# 3330B

FA 000547

# Programmable Constant Volt./ Constant Current Calibrator

## Instruction Manual

P/N 313460
January 1971
Rev. 2 4/75

FLUKE ®

# WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

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1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number. On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

**SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT**

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

**CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER**

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

**John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206**

Rev. 6/81

**CHANGE/ERRATA INFORMATION**

**ISSUE NO: 11 8/86**

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The revision letter stamped on the indicated PCB is equal to or higher than that given with each change.
2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

| | |
|---|---|
| Title: | 3330B |
| Print Date: | January 1971 |
| Rev.- Date: | 2-4/75 |

C/E PAGE EFFECTIVITY

| Page No. | Print Date |
|---|---|
| 1 | 9/82 |
| 2 | 9/82 |
| 3 | 9/82 |
| 4 | 9/82 |
| 5 | 9/82 |
| 6 | 9/82 |
| 7 | 9/82 |
| 8 | 9/82 |
| 9 | 9/82 |
| 10 | 9/82 |
| 11 | 9/82 |
| 12 | 9/82 |
| 13 | 9/82 |
| 14 | 10/83 |
| 15 | 10/83 |
| 16 | 10/83 |
| 17 | 10/83 |
| 18 | 10/83 |
| 19 | 10/83 |
| 20 | 8/86 |
| 21 | 8/86 |
| 22 | 8/86 |
| 23 | 8/86 |

CHANGE #1 - 10077, 10796

On page 5-3:
CHANGE: A3|Front Mother Board Assembly (3330-4006)|286310|1
TO: A3|Front Mother Board Assembly (3330-4008)|448654|1

CHANGE: A4A4|Series Pass Driver Assembly (333A-4024)|275388|1
(See Figure 5-11)
TO: A4A4|Series Pass Driver Assembly (333A-4030)|446813|1
(See Figure 5-11)

On page 5-5, change the stock numbers for A3 and A4A4:
FROM: 286310, 275388
TO: 448654, 446813

On page 5-6, change the stock number on Figure 5-1 (sheet 2 of 2) A3:
FROM: 286310
TO: 448654

On page 5-9:
CHANGE: DS1 thru DS10 |Lamp, incadescent, 28v|246686|10|10
TO: CR21 thru CR30|LED Assy |429555|10|10

DELETE: XDS1 thru XDS10|Lampholder|278986|10
Lens, decimal lamp, clear|271643|8
Lens, decimal lamp, red|282475|2

On page 5-10, change the reference designators:
FROM: DS1 through DS10
TO: CR21 through CR30

On page 5-13:
ADD: R52, R53, R54|Res, comp, 1.5k +/-10%, 1w |109413|3
R55, R56 |Res, comp, 3.3k +/-10%, 1/2w|108373|2

On page 5-32:
CHANGE: R26|Res, comp, 330Q +/-5%, 2w |219063|1
TO: R26|Res, comp, 2.2k +/-10%, 1w|109843|1

On page 5-38:
Delete the entire listing for R3.
Delete R9 and R25 from the R8,R9,R25,R26 listing and change the TOT QTY: FROM: 4 TO: 2.

On page 5-39, delete R3, R9 and R25 in the lower right quadrant of Figure 5-14.

On page 8-6:
Change the reference designators DS1 through DS10 to CR21 through DR30 in the existing sequence. The cathode of the diode goes to the left in all ten cases.

Insert R52 (1.5k) between the cathode junction of CR21 through CR24 and the -25V supply.

Insert R53 (1.5k) between the cathode junCtion of CR27 and CR28 and the

-25V supply.

Insert R54 (1.5k) between the cathode of CR30 and the -25V supply.

Insert R55 (3.3k) between the cathode of CR26 and the tie-point to the right of R3 and the emitter of Q3.

Insert R56 (3.3k) between the anode of CR25 and pin 36.

On page 8-13, Figure 8-11, change the value of R26:
FROM: 330
TO: 2.2k

On page 8-16, Figure 8-14:
DELETE: R3 (150Ω)
R9 (120Ω)
R25 (120Ω)

CHANGE #2 - 10784

On page 5-3, reference designator A4A10, change the drawing number and the stock number:

| | | |
|---|---|---|
| FROM: | (333A-4029) | 275420 |
| TO: | (333A-4009) | 463398 |

On page 5-48, change the title of Figure 5-17:
FROM: Figure 5-17. LADDER DRIVER NO. 1 ASSEMBLY
TO: Figure 5-17. LADDER DRIVER NO. 1 AND 2 ASSEMBLY

On page 5-49:
Change the reference of Figure 5-18, to Figure 5-17.

Change the stock number for A4A11:
FROM: 275420
TO: 463398

Change the entire A4A11 parts list to match the A4A10 parts list located on page 5-47 with the following exception:

R6|Res, var, cermet, 20Ω +/-30%, 3/4w|186197|1

On page 5-51, change the title of Figure 5-18:
FROM: Figure 5-18. LADDER DRIVER NO. 2 AND 3 ASSEMBLY
TO: Figure 5-18. LADDER DRIVER NO. 3 ASSEMBLY

On page 8-20, Figure 8-18:
Change the figure to match Figure 8-17 (page 8-19), then change R6 from a 10 ohm fixed resistor to a 20 ohm variable resistor with the wiper tied to the leftside.

ERRATA #1

On page 1-2, under "COMPLIANCE VOLTAGE":
CHANGE: (see voltage limit)
TO: (see voltage trip)

On page 1-3, Table 1-1:
Under the CODING column for CURRENT LIMIT:
CHANGE: 1.0 TO: *

Under the CODING column for REMOTE TRIP LEVEL:
CHANGE: <1% TO: *

At the end of the table, place the following footnote: * Not usable

ERRATA #2

On page 1-4, under RESPONSE TIME:
CHANGE: -300 milliseconds typical
TO: -300 milliseconds typical above 100 uA.

On page 1-5/1-6:
Under SHOCK and VIBRATION:
CHANGE: (MIL-T-21200)
TO: (MIL-T-28800 class 5)

Under SIZE:
CHANGE: 7" high X 17" wide X18" deep
TO: 7" (178 mm) high X 17" (432 mm) wide X 18" (458 mm) deep

Under WEIGHT:
CHANGE: 58 lbs
TO: 58 lbs (26.3 kg)

On page 5-27, change the description and the stock number:

| | | |
|---|---|---|
| FROM: | Tstr, silicon, NPN | 177105 |
| TO: | tstr, selected | 437723 |

On page 5-33, change the stock no. for C2:
FROM: 190468
TO: 194068

Add the following new listings to MANUFACTURERS CROSS REFERENCE LIST on the pages indicated:

| | |
|---|---|
| On page 5-67: | 109413;00121;GB1521<br>109843;01121;GB2221 |
| On page 5-69: | 170274;73445;ET 151X063A01 |
| On page 5-73: | 429555;12040;NSL 5053/NSC003<br>437723;89536;437723<br>448613;89536;448613<br>448654;89536;448654<br>463398;89536;463398 |

ERRATA #3

On page 4-1, Table 4-1, under the RECOMMENDED EQUIPMENT column:
CHANGE: Tektronix Model 545B
TO: Tektronix Model 545B with 1A1 or differential plug-in module


9/82

On page 4-19, para. 4-75, delete the warning preceeding step e, and add the following warning prior to step a:

WARNING

TO AVOID ELECTRICAL SHOCK USE A SCOPE CAPABLE OF MAKING DIFFERENTIAL MEASUREMENTS, I.E., MEASURING A FLOATING INPUT SIGNAL. DO NOT GROUND ANY OF THE MEASUREMENT POINTS SPECIFIED TO SCOPE CHASSIS (VIA THE LOW INPUT LEADS). INTERPRET SCOPE HIGH INPUT AS CHANNEL A, AND SCOPE LOW INPUT AS CHANNEL B. IF A 1A1 PLUG-IN IS USED, SELECT THE "ADD" MODE AND USE THE A/B INPUTS FOR HIGH/LOW SIGNAL CONNECTIONS.

**ERRATA #4**

On page 4-11, para. 4-49, step d:
CHANGE: A7R1
TO: A7R2

On page 4-16, Table 4-16:
Change A7R1 located under PROCEDURE for STEP 4 to A7R2.

On pages 8-4, Figure 8-2 and 8-5, Figure 8-3:
CHANGE: R1
TO: R2 and indicate 5k

**CHANGE #3**

On page 5-4, change the stock number for the line cord:
FROM: 226100
TO: 284174

On page 5-7, change the description and stock number for J7:

| | | |
|---|---|---|
| FROM: | Connector, male, 3 contact | 159012 |
| TO: | Connector, Line-power, 3-contact | 284166 |

**ERRATA #5**

On page 3-15, Figure 3-8, and page 8-6, Figure 8-4, make the changes shown in Figure 1.

**ERRATA #6**

On page 1-2, add (DC to 10 kHz) to both the RIPPLE AND NOISE spec's.

**ERRATA #7**

On page 4-2, para. 4-12:
CHANGE: F1, 1/8, Fast-Blo (115/230V ac)
TO: F1, 1/4, Fast-Blo (115/230V ac)

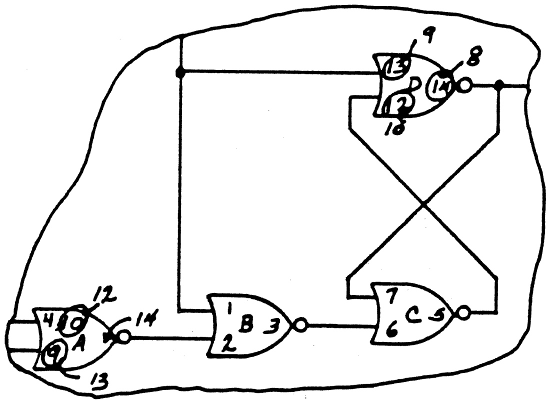



Figure 1.

On page 5-7:
CHANGE: F1|Fuse, fast acting, 1/8 amp, 250v|196790|1|10
TO: F1|Fuse, fast acting, 1/4 amp, 250V|109314|1|10

On page 5-67:
ADD: 109314/71400/AGC1-4

ERRATA #8

On page 1-2, under GENERAL SPECIFICATIONS, add the following information:

Protection Class ................. #1 (Relates solely to insulation or grounding properties further defined in IEC 348.)

CHANGE #4 - 12822
Rev.- K, Final Assembly (3330B-5001)

On page 5-8:
CHANGE: C4,C5|Cap, cer, 0.01 uf, 500v|105684|2
(mounted on J7)
TO: C4,C5|Cap, cer 0.005 uf, 25V rms|485839|2
(mounted on J7)

On page 8-4, change the value of C4 and C5, mounted on J7:
FROM: 0.1
TO: 0.005

CHANGE #5 - 12938
Rev.- D, A4A1 +10 Volt Reference Supply Assy (333A-4005)

On page 5-3:
CHANGE: A4A1|+10 Volt Reference Supply Assembly (333A-4005) |251926|1
(See Figure 5-8)
TO: A4A1|+10 Volt Reference Supply Assembly (3330A-4013T)|577080|1
(See Figure 5-8)

On page 5-22:
Delete entire entries: C5, CR1, CR2, IC1, R5, R6, R7, R8, R9,R23,

R16,R17,R18.

CHANGE: A4A1|+10 VOLT REFERENCE SUPPLY ASSEMBLY|251926|REF
Figure 5-8
TO: A4A1|+10 VOLT REFERENCE SUPPLY ASSEMBLY|577080|REF
Figure 5-8

ADD: C1|Cap, mica, 100 pf +/-5%, 500v|148494|1

CHANGE: C2|Cap, elect, 400 uf +10/-50%, 25v|168153|1
TO: C2|Cap, TA, 10 uf +/-20%, 20v |330662|1

CHANGE: C3|Cap, plstc, 1 uf +/-10%, 250v|190330|2
TO: C3|Cap, mylar, 1 uf +/-20%, 200v|106450|1

CHANGE: C4|Cap, plstc, 0.047 uf +/-10%, 40v|162008|1
TO: C4|Cap, film, 4 uf +/-20%, 50 dcv |340281|1

ADD: CR1,CR2|Diode, silicon, LO-CAP, LO-LEAK|348177|2
CR3 |Diode, zener, 5.6v |277236|1
CR4 |Diode, field effect |334839|1

CHANGE: Q1|Tstr, silicon, NPN|168708|1
TO: Q1|Tstr, silicon, NPN|203489|1

CHANGE: R1|Res, comp, 39k +/-5%, 1/2w|186049|1
TO: R1|Res, comp 330 +/-5%, 1w |163394|1

CHANGE: R3|Res, met film, 16.5k +/-1%, 1/2w|162529|1
TO: R3|Res, met film, 16.5k +/-1%, 1/8w|349159|1

CHANGE: R4|Res, met film, 2.32k +/-1%, 1/2w|262014|1
TO: R4|Res, met film, 2.32k +/-1%, 1/8w|347062|1

CHANGE: R14|Res, met film, 1.15k +/-1%, 1/2w|155010|1
TO: R14|Res, met film, 886 +/-1%, 1/8w |248641|1

CHANGE: R19,R20,R21|Res, var, ww, 10k +/-10%, 1-1/4w |195164|3
TO: R19,R20,R21|Res, var, cermet, 10k +/-20%, 1/2w|267880|3

CHANGE: IC2,R2,R11,R15|Reference Amplifier matched Set|224824|1
TO: U2,R2,R11,R15 |Reference Amplifier mathced Set|224824|1

ADD: U1|IC,LIN,OP AMP|284960|1
SPACER, TRANSIPAD|152207|1

On page 5-23, Figure 5-8:
Replace Figure 5-8 with Figure 2.

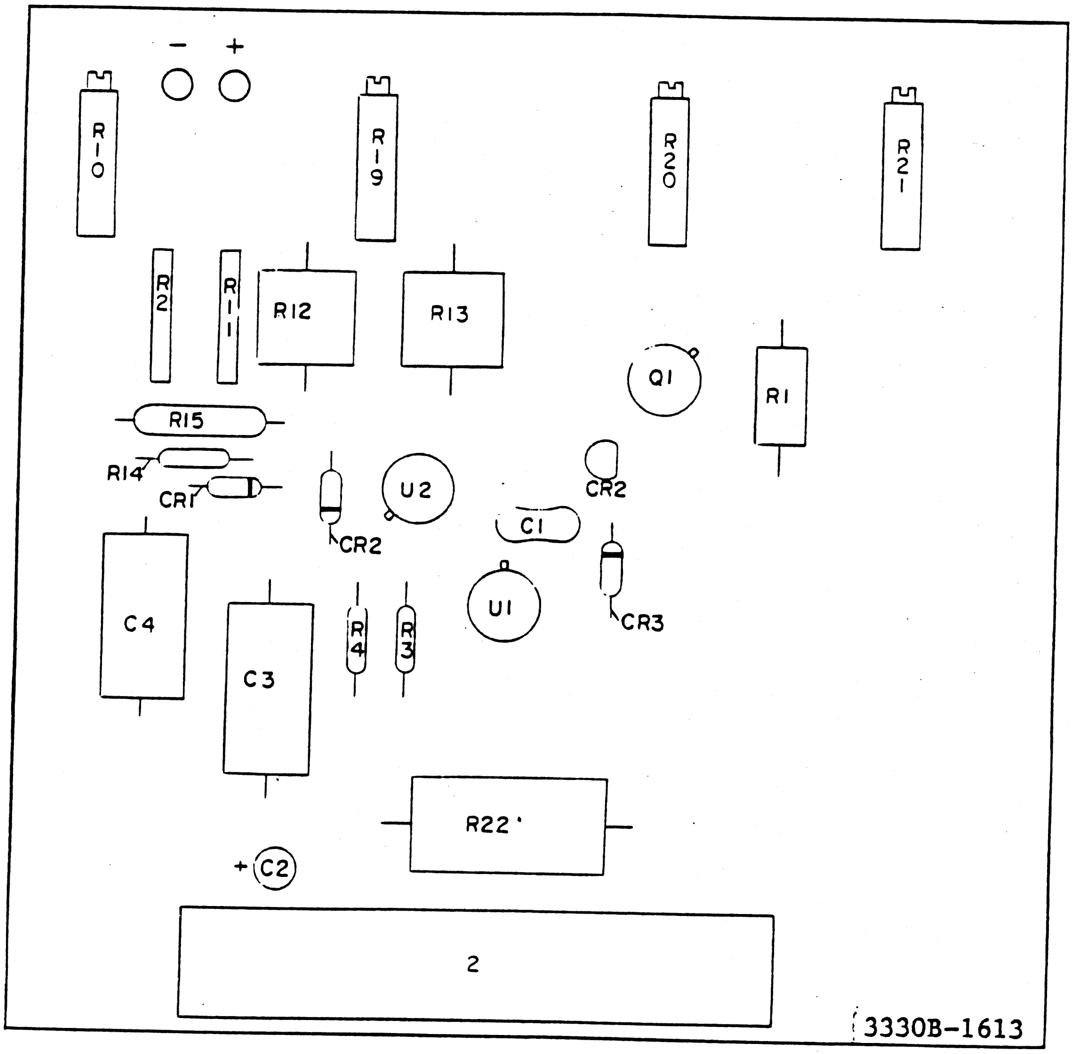
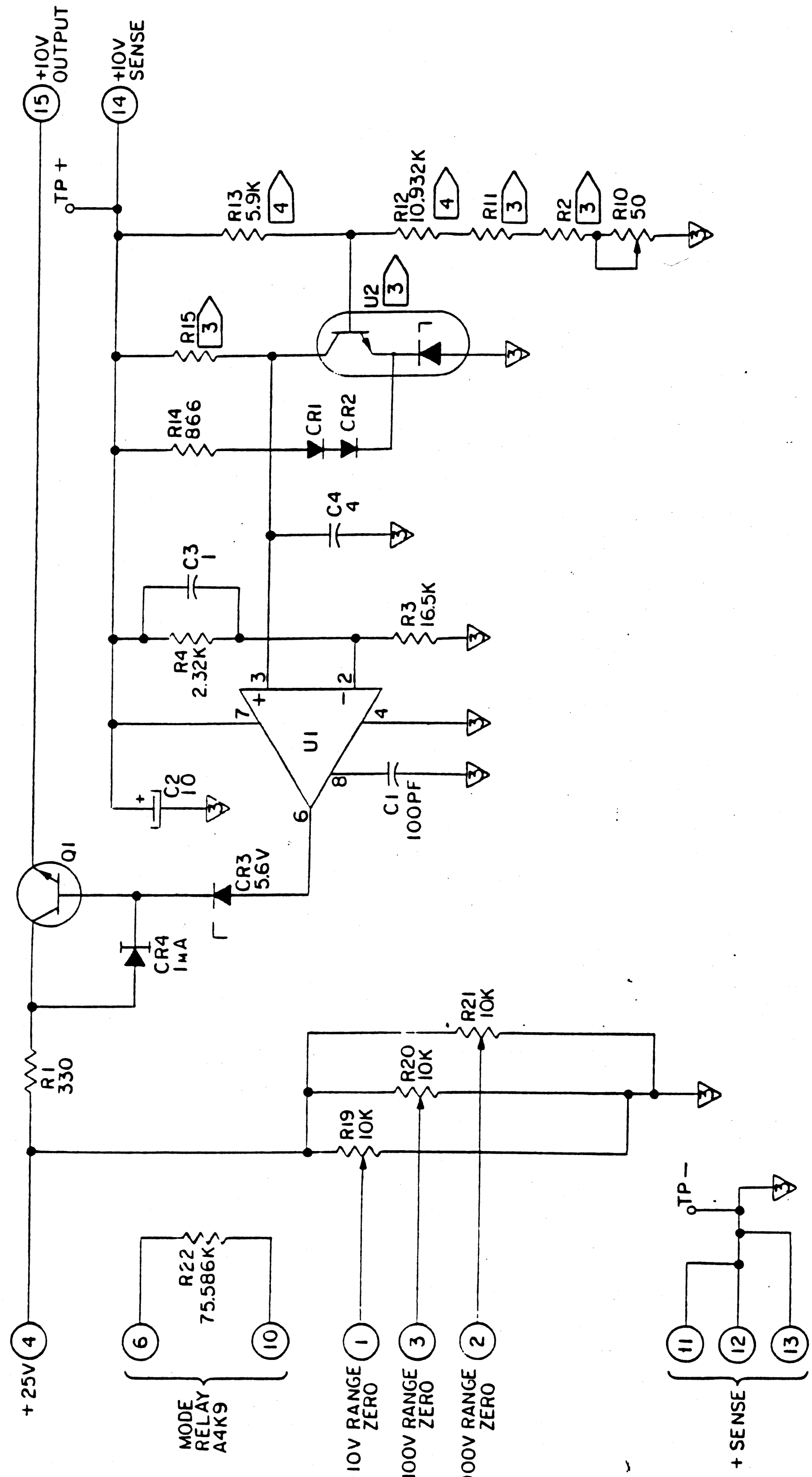



Figure 2.

On page 8-10, Figure 8-8:
Replace Figure 8-8 with Figure 3.




3330B-1013

Figure 3.

CHANGE #6 - 12941
Rev.-D, Switch Board Assembly (3330-4007)

On page 5-16:
ADD: Pushbutton, Red|268870|2
Pushbutton, Black|28888|2

On pages 5-16 and 5-17:
Change the STOCK NO.'s for S1 thru S5, S6 thru S10, and S11 thru S1
respectively:

| | | | |
|---|---|---|---|
| FROM: | 257063 | 257071 | 257089 |
| TO: | 380980 | 380998 | 381004 |

CHANGE #7 - 13023
Rev.-B, Front Mother Assy (3330B-4088)

On page 5-11:
CHANGE: CR2 thru CR10,
CR13 thru CR24 |Diode, silicon 150 ma|203323|21|2
TO: CR2 thru CR10,
CR13 thru CR24, CR32|Diode, silicon 150 ma|203323|22|5

On page 8-6:
Change the schematic as shown in Figure 4.

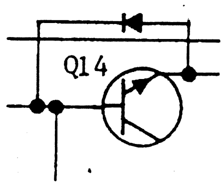



Figure 4.

CHANGE #8 - 13558
Rev.-A, Relay Assembly (3330B-4004)

On page 5-4:
CHANGE: A6|Relay Board Assembly (3330B-4004)|286195|1
(See Figure 5-25)
TO: A6|Relay Board Assembly (3330B-4004)|576488|1
(See Figure 5-25)

On page 5-66:
Change the STOCK NO. for A6 on the parts list and Figure 5-25:
FROM: 286195
TO: 576488



9/82

CHANGE #9 - 13625
Rev.-N, Rear Panel Final Assy (3330B-5001)

On page 5-7:
CHANGE: XF1,XF2|Fuseholder |160846|2
TO: XF1,XF2|Fuseholder -body|375188|2
-cap |460238|2

CHANGE #10 - 13690
Rev.-F, Main Mother Board Assembly (3330-4001)

On page 5-21, change the STOCK NO. for K1 thru K5:
FROM: 281170
TO: 543827

CHANGE #11 - 14113
Rev.-C, Power Supply Assembly (333A-4003)

On pages 5-4 and 5-60, change the STOCK NO. for A5A1:
FROM: 251900
TO: 362327

On page 5-60:
ADD: E1,E2|Ferrite, choke core|219535|2

On page 8-26, add E1 and E2 as shown in Figure 5.

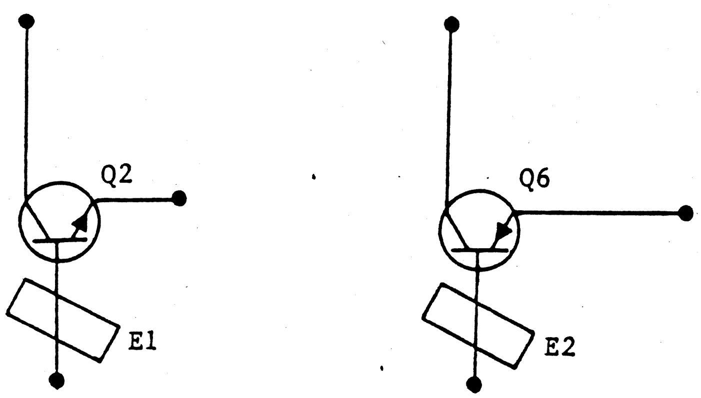



Figure 5.

CHANGE #12 - 14337
Rev.-G, Chopper Amplifier Assy (333A-4004)

On page 5-24:
Delete entire entries for CR2 thru CR5 and CR6, CR7.
ADD: CR2 thru CR9|Diode, SI, Hi-speed switching|203323|8

CHANGE: Q2|Tstr, FET, N-channel |166223|1
TO: Q2|Tstr, J-FET, P-channel|271924|1

CHANGE: Q4|Tstr, silicon, PNP |261032|1
TO: Q4|IC,PNP, silicon, small signal|288761|1

On page 5-26:
CHANGE: R30|Res, comp, 8.2k +/-5%, 1/4w|160796|1
TO: R30|Res, comp, 3.3k +/-5%, 1/4w|348813|1

CHANGE: R35|Res, met flm, 24.3k +/-1%, 1/2w|217430|1
TO: R35|Res, met flm, 12k +/-1%, 1/4w |348847|1

On page 8-11, Figure 8-9, change the values of R30 and R35:
FROM: 8.2K and 24.3
TO: 3.3K and 12K

CHANGE #13 - 14460
Rev.-E, Preregulator Assembly (332B/AF-4082)

On pages 3-12 and 3-13, delete paragraphs 3-101 thru 3-107 and replace with the following:

3-101. Pre-Regulation Circuitry

3-102. OSCILLATOR. A unijunction oscillator, consisting of Q9 and associated circuitry, is located on the A4A5 Series Pass Element P/C Assembly (333A-1034). Applied to base two of Q9 is 6.8v clipped, full-wave rectified, 60 Hz sine wave. The potential at the emitter of Q9 depends upon the charge of C4 and C5. The charge of C5 depends upon the voltage across the main series pass element, Q8. At the trailing edge of each pulse at the base two of Q9, the oscillator provides a series of positive pulses until the leading edge of the next +6.8 volt pulse occurs. With an increased charge across C4 and C5, the initial output pulse of the oscillator will occur earlier in each half cycle. The initial pulse from the oscillator during each half cycle will switch the preregulator off to control the amount of line power supplied to the high voltage transformer. If the series pass element voltage of Q8 increases, the pre-regulator is switched off earlier in each half cycle. This in turn reduces the series pass element voltage of Q8 to its equilibrium value.

3-103. The +6.8 volt operating voltage for the oscillator circuit is taken from the +150 volt supply for the series pass element. A portion of the +150 volt supply is applied to the voltage divider consisting of R1 through R3. The divided-down voltage is regulated by zener diode CR6 to approximately +6.8 volts.

3-104. PRE-REGULATOR. The A5A2 Preregulator (332B/AF-1081) controls the ac power supplied to the instrument by passing only enough power to the A4A6 H. V. Power Supply to meet the output load requirement. It consists of a +/-V supply, a relay power supply, preregulator control drivers, a preregulator bridge, and a current limiter.

3-105. +/-V and +10V dc operating voltages are produced for the A5A2 Preregulator by the rectifier CR1 through CR4 and associated components. A 10V ac input is applied to CR1 through CR4. The dc output at the junction of CR2 and CR4 is filtered by C3 to provide a -V operating voltage. The dc voltage at the junction of CR3 and CR1 is heavily loaded by R1 to provide an unfiltered +V operating voltage. This voltage is also isolated through CR5 and filtered by C4 to provide a +10V dc operating voltage.

3-106. Operating voltage for relay K1, which supplies ac voltage to the preregulator bridge, is produced by bridge rectifier CR6 through CR9 and K2. AC return for the bridge rectifier is provided through the contacts of K2. This relay is energized only in the OPR mode by a control voltage from the A4A4 Series Pass Driver. The A4A4 Series Pass Driver automatically removes the control voltage from K2 should a VOLTAGE TRIP occur, thus removing ac power to the preregulator bridge and establishing a STDBY condition.

3-107. The circuitry consisting of Q2 through A9 controls the condition of the preregulator bridge attenuator, Q1. Input pulses from the VCO in the A4A5 Series Pass are supplied to the base of Q7 via terminal 14. The first pulse turns on Q7 and Q6, which through regenerative action, saturate. This condition turns off Q5 and causes Q4 and Q8 to also turn off. Q9 is subsequently turned on by the -V collector voltage of Q8 and provides a negative voltage at the base of Q2. This condition turns off Q2 and also Q1, thus causing the preregulator bridge of CR10 through CR13 and Q1 to provide maximum attenuation to the ac voltage applied to the A4A6 H.V. Power Supply. When the ac line passes through zero, the 0V, +V condition at the emitter of Q6 causes it to turn off and also turns off Q7. This condition reverses the previously described state of each transistor and the preregulator bridge again passes the ac line voltage to the A4A6 H.V. Power Supply.

3-107a. AC line voltage applied to T2 and subsequently the A4A6 H.V. Power Supply is controlled through the preregulator bridge consisting of CR10 through CR13 and Q1. The previously described circuitry of Q2 through A9 controls condition of Q1. Diodes CR10 through CR13 provide a unidirectional current through Q1. Positive alternations are passed by CR10 and CR13. CR12 and CR11 pass negative alternations. Should Q1 be cut off, C6 and R5 provide a dynamic load for the bridge. Overload current protection for Q1 is provided through divider R2, R8, and R9 and Q3. Should the current through Q1 exceed 17 amperes, the voltage at the base of Q3 turns it on and causes Q6 to saturate. This condition causes Q1 to be cut off, thus limiting the current through the preregulator bridge.

On page 5-4:
CHANGE: A5A2|Preregulator Assembly (332B/AF-4082) |222000|1
TO: A5A2|Preregulator Assembly (332B/AF-4081T)|610543|1

On page 5-58, change the STOCK NO. for A5A2:
FROM: 222000
TO: 610543

On pages 5-63 and 5-65:
Replace the entire A5A2 parts list for Table 1.

Table 1.

| REF DES | DESCRIPTION | FLUKE STOCK NO. | MFG SPLY CODE | MFG PART NO. | TOT QTY | REC QTY | NOTE |
|---|---|---|---|---|---|---|---|
| A5A2 | PREREGULATOR PCB ASSEMBLY FIGURE 5-24 | 610543 | 89536 | 610543 | REF | | |
| C1 | CAP, CER, 0.05 UF +80/-10%, 500V | 105676 | 56289 | 33C58B | 4 | | |
| C2 | CAP, CER, 0.05 UF +80/-10%, 500V | 105676 | 56289 | 33C58B | REF | | |
| C3 | CAP, ELECT, 330 UF, -10/+50%, 16V | 187765 | 73445 | C437ARE250 | 2 | | |
| C4 | CAP, ELECT, 330 UF, -10/+50%, 16V | 187765 | 73445 | C437ARE250 | REF | | |
| C5 | CAP, PLSTC, 1 UF +/-20%, 200V | 106450 | 72928 | 364 | 1 | | |
| C6 | CAP, CER, 0.05 UF +80/-10%, 500V | 105676 | 56289 | 33C58B | REF | | |
| C7 | CAP, MYLAR, 0.001 UF +/-10%, 200V | 159582 | 56289 | 192P10292 | 1 | | |
| C8 | CAP, CER, 0.05 UF +80/-10%, 500V | 105676 | 56289 | 33C58B | REF | | |
| C10 | CAP, PLSTC, 0.47 UF +/-10%, 250V | 184366 | 73445 | C280AE/470K | 1 | | |
| CR1 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | 8 | 2 | |
| CR2 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR3 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR4 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR5 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR6 | DIODE, SILICON, 1 AMP, 600 PIV | 112383 | 05277 | 1N4822 | 4 | 1 | |
| CR7 | DIODE, SILICON, 1 AMP, 600 PIV | 112383 | 05277 | 1N4822 | REF | | |
| CR8 | DIODE, SILICON, 1 AMP, 600 PIV | 112383 | 05277 | 1N4822 | REF | | |
| CR9 | DIODE, SILICON, 1 AMP, 600 PIV | 112383 | 05277 | 1N4822 | REF | | |
| CR10 | DIODE, SILICON, 3 AMP, 200PIV | 187716 | 04713 | MR1032B | 4 | 1 | |
| CR11 | DIODE, SILICON, 3 AMP, 200PIV | 187716 | 04713 | MR1032B | REF | | |
| CR12 | DIODE, SILICON, 3 AMP, 200PIV | 187716 | 04713 | MR1032B | REF | | |
| CR13 | DIODE, SILICON, 3 AMP, 200PIV | 187716 | 04713 | MR1032B | REF | | |
| CR14 | DIODE, ZENER, 200V | 187617 | 04713 | 1N3350RA | 1 | 1 | |
| CR15 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR16 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| CR17 | DIODE, SILICON, 1 AMP, 100 PIV | 116111 | 05277 | 1N4817 | REF | | |
| K1 | RELAY, ARMATURE, 115 VAC, DPDT | 106864 | 16332 | 100-5ADPDT | 1 | | |
| K2 | RELAY, REED, 500V | 136630 | 12617 | TYPE DRG-1 | 1 | | |
| | COIL, REED RELAY, 24V | 186155 | 71707 | SP-24-P | 1 | | |
| MP1 | COMPONENT HOLDER | 104794 | 98159 | 2829-115-3 | 1 | | |
| MP2 | TRANSIPAD SPACER | 152207 | 07047 | 10123-DAP | 1 | | |
| P1 | CONNECTOR, MALE, 16 CONTACT | 187724 | 91662 | 02-016-013-5-200 | 1 | | |
| Q1 | TSTR, SILICON, NPN | 586552 | 03508 | 064VS5 | 1 | 1 | |
| Q2 | TSTR, SILICON, PNP | 261347 | 16758 | TYPE DTS410 | 1 | 1 | |
| Q3 | TSTR, SILICON, NPN | 203489 | 07910 | CDQ10656 | 3 | 1 | |
| Q4 | TSTR, SILICON, PNP | 159491 | 89536 | 4805-159491 | 4 | 1 | |
| Q5 | TSTR, SILICON, NPN | 203489 | 07910 | CDQ10656 | REF | | |
| Q6 | TSTR, SILICON, PNP | 159491 | 89536 | 4805-159491 | REF | | |
| Q7 | TSTR, SILICON, NPN | 203489 | 07910 | CDQ10656 | REF | | |
| Q8 | TSTR, SILICON, PNP | 159491 | 89536 | 4805-159491 | REF | | |
| Q9 | TSTR, SILICON, PNP | 159491 | 89536 | 4805-159491 | REF | | |
| R1 | RES, COMP, 68 +/-10%, 2W | 110205 | 01121 | HB6801 | 1 | | |
| R2 | RES, WW, 0.192 +/-1%, 3W | 238741 | 89536 | 238741 | 1 | | |
| R4 | RES, WW, 2K +/-5%, 5W | 113506 | 44655 | 1538 | 1 | | |
| R5 | RES, COMP, 22K +/-5%, 1/2W | 186064 | 01121 | EB2235 | 1 | | |
| R6 | RES, WW 1 +/-10%, 5W | 112425 | 44655 | 1K48F | 1 | | |
| R7 | RES, COMP 220 +/-10%, 1/2W | 108191 | 01121 | EB2211 | 1 | | |

Table 1. (continued)

| REF DES | DESCRIPTION | FLUKE STOCK NO. | MFG SPLY CODE | MFG PART NO. | TOT QTY | REC QTY | NOTE |
|---|---|---|---|---|---|---|---|
| R8 | RES, COMP 430 +/-5%, 1/2W | 109058 | 01121 | EB4315 | 1 | | |
| R9 | RES, COMP 100 +/-10%, 1/2W | 188508 | 01121 | EB1015 | 1 | | |
| R10 | RES, COMP 2.2K +/-5%, 1/2W | 108506 | 01121 | EB2035 | 1 | | |
| R11 | RES, COMP 100 +/-5%, 1W | 190652 | 01121 | EB1015 | 1 | | |
| R12 | RES, COMP 1K +/-5%, 1/2W | 108597 | 01121 | EB1025 | 4 | | |
| R13 | RES, COMP 1K +/-5%, 1/2W | 108597 | 01121 | EB1025 | REF | | |
| R14 | RES, COMP 1K +/-5%, 1/2W | 108597 | 01121 | EB1025 | REF | | |
| R15 | RES, COMP 4.7K +/-5%, 1/2W | 108886 | 01121 | EB4725 | 1 | | |
| R16 | RES, COMP 3.3K +/-5%, 1/2W | 165761 | 01121 | EB3325 | 1 | | |
| R17 | RES, COMP 1K +/-5%, 1/2W | 108597 | 01121 | EB1025 | REF | | |
| R18 | RES, COMP 560 +/-5%, 1/2W | 109124 | 01121 | EB5615 | 1 | | |
| R19 | RES, COMP 68 +/-5%, 1/2W | 178384 | 01121 | EB6805 | 1 | | |
| R20 | RES, COMP 30 +/-5%, 1/2W | 218792 | 01121 | EB3005 | 1 | | |

On page 5-64, Figure 5-24, replace entire figure with Figure 6.

On page 8-27/8-28, Figure 8-25, replace the entire figure for Figure 7.

**ERRATA #9**

On page 8-9, Figure 8-7, change polarity of CR38 to be in series with CR39 rather than back to back.

**ERRATA #10**

On page 4-6, para. 4-32, step d:

**CHANGE:** d. Advance the Decade Dials to 10x.xx000. When this new setting is reached, the I LIMIT/V TRIP lamp should illuminate and the OPR lamp should go out.

**TO:** d. Advance the Decade Dials to 10X.XX. The I LIMIT/VTRIP lamp should not illuminate. Verify that trip will occur if the voltage trip vernier is adjusted less than approximately 1/4 inch from maximum setting.

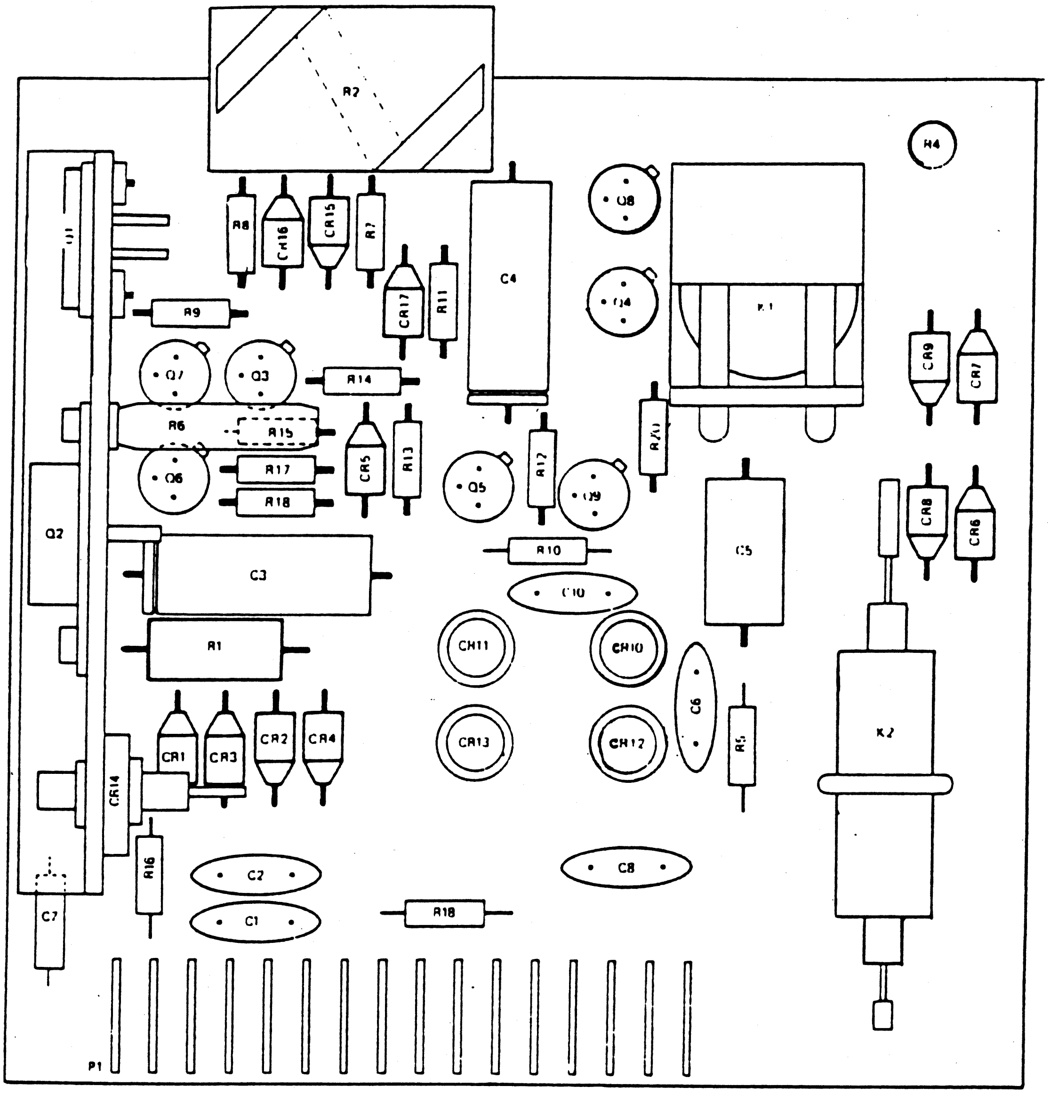
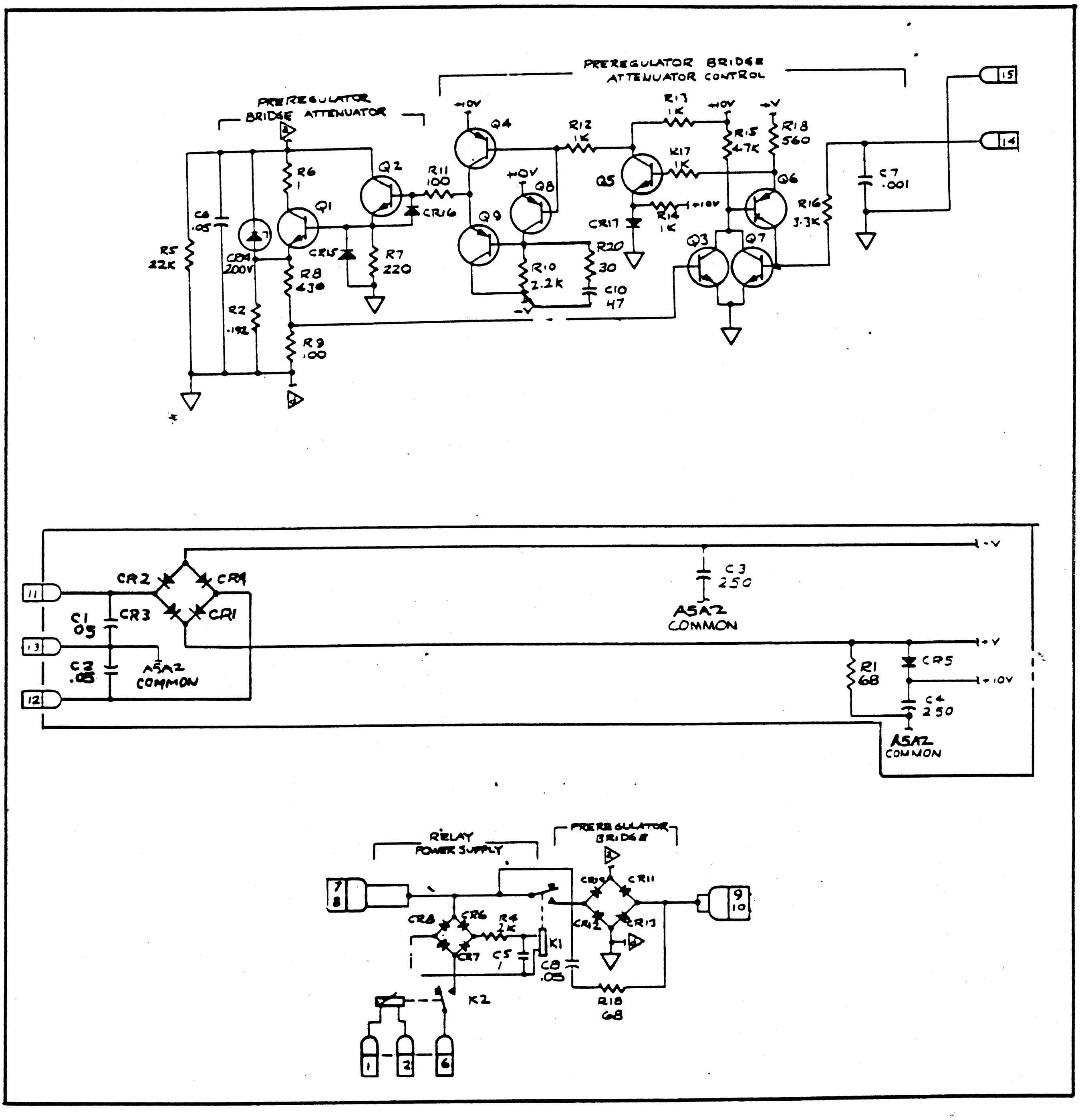

R2
R4
R8
CR16
CR15
R7
CR17
R11
C4
Q8
Q4
K1
R9
Q7
Q3
R14
R6
R15
R17
R18
Q6
CR5
R13
Q5
R12
Q9
R20
CR9
CR7
CR8
CR6
Q2
C3
R10
C10
C5
R1
CR11
CR10
C6
CR13
CR12
R5
K2
CR1
CR3
CR2
CR4
CR14
R16
C2
C1
C8
R18
C7
P1

Figure 6.



PREREGULATOR BRIDGE ATTENUATOR
PREREGULATOR BRIDGE ATTENUATOR CONTROL
R5 22K
C6 .05
CR4 200V
R2 .192
R6 1
Q1
R8 430
R9 .100
Q2
CR15
R7 220
R11 100
CR16
Q4
Q9
Q8
R10 2.2K
R20 30
C10 47
R12 1K
R13 1K
Q5
K17 1K
CR17
R14 1K
R15 4.7K
R18 560
Q6
Q3
Q7
R16 3.3K
C7 .001
15
14
CR2
CR4
CR3
CR1
C1 .05
C2 .05
ASA2 COMMON
C3 250
R1 68
CR5
C4 250
11
13
12
RELAY POWER SUPPLY
PREREGULATOR BRIDGE
CR8
CR6
CR7
R4 2K
C5 1
K1
C8 .05
CR11
CR12
CR13
R18 68
K2
9 10
7 8
1
2
6


Figure 7.

**CHANGE #14 - 15173**
Rev.-H, Chopper Amplifier, Assy (333A-4004)

On page 5-24:
CHANGE: Q1|Tstr, MOS FET, P-channel|226043|1
TO: Q1|Tstr, MOS FET, P-channel |306142|1

**CHANGE #15 - 16081**
Rev.-F, Current Limiter Assembly (333A-4032)

On page 5-38:
CHANGE: Q2|Tstr, germanium, PNP|152868|1|1
TO: Q2|Tstr, silicon, PNP |483222|1|1

**CHANGE #16 - 16475**
Rev.-G, Main Motherboard Assembly (3330B-4001)

On page 5-21:
CHANGE: R5|Res, comp, 333 +/-5%, 1w|163394|1
TO: R5|Res, comp, 1k +/-10%, 1w|109371|1

On page 8-9, change the value of R5:
FROM: 330
TO: 1K

**ERRATA #11**

On page 4-20, para. 4-81:
CHANGE: step b to d
step c to b
step d to c

Add the following to the new step c:
STDBY/OPR OPR

Delete the last sentence in the new step d and add the following:

> Use current limiting in the general purpose supply of approximately 20 to 50 mA. After the 3330B is in OPERATE, set the general purpose supply output for 5.5V dc.

**ERRATA #12**

On page 5-4:
ADD: Guide, PCB card|241455|38

**CHANGE #17 - 15821**
Rev.-S, Final Assembly (3330B-5001)

On pages 5-19 and 5-50, change the STOCK NO for A4A12,
FROM: 275412
TO: 612531

On pages 5-19 and 5-52, change the STOCK NO for A4A13,
FROM: 252031
TO: 612549

On pages 5-19 and 5-54, change the STOCK NO for A4A14, A4A15 and A4A16,
FROM: 251892
TO: 612556

On pages 5-50, 5-52 and 5-54,

| | | | | | |
|---|---|---|---|---|---|
| CHANGE: | K1 thru K4 | Reed relay, | 267708 | 4 | 2 |
| | | Coil, reed relay | 186155 | 4 | 1 |
| TO: | K1 thru K4 | Reed relay, encapsulated | 603563 | 4 | 1 |

**ERRATA #13**

On page 4-1, para 4-2, replace the last sentence with:
Equipment having equivalent specifications may be used.

**ERRATA #14**

On page 4-4, para. 4-24, make the following changes.

Step d, replace the first sentence with:
"Connect a X1000, 10 kHz Bandwidth preamplifier to the OUTPUT terminals."

Step e:
CHANGE: 200 uv
TO: 200 mV

Step f:
CHANGE: 1.0 mv
TO: 1V

Replace step g with:

g. "Select the 100 mA range, and then connect the rms voltmeter directly to the Model 3330B OUTPUT terminals. The rms voltmenter indication should be less than 100 mV.

In Table 4-3, add an * to the S1 POSITION column heading, and add the following note to the bottom of the table.

* Go to standby and reduce decade to 6 before opening switch then return to OPERATE and increase decade back to 10.

On page 4-7, para 4-34, replace steps d, e and f with:

d. Advance the Decade Dials to 10X.XX. The I LIMIT/VTRIP lamp should not illuminate. Verify illumination at a current limit control setting less than approximately 1/4 inch from max.

e. Set the Decade Dials to 03.00000. The I LIMIT/VTRIP lamp should be off.

f. Slide the current limit control towards the LO setting. The I LIMIT/VTRIP lamp should illuminate at approximately 1/4 inch or less from the minimum setting.

## ERRATA #15

On page 4-5, para. 4-26, step C, change to read:

c. Connect a power supply calibrator (Fluke model 7105A System as pictured on page 2-4, Figure 2-4 of the 7100 manual) to the 3330B output terminals.

In Table 4-5A, add a column labeled NULL DETECTOR INDICATION, and an entry of 0 ± 30 uV for each step 1 thru 8.

In Table 4-5B, change the RSTD and the OUTPUT CURRENT (RSTD VDC) columns for steps 1, 4 and 7:

| | | | |
|---|---|---|---|
| **FROM:** | 1 | 1k | 0.1 ±6 uv |
| | 4 | 100Q | 0.1 ±6 uv |
| | 7 | 10Q | 0.1 ±6 uv |
| **TO:** | 1 | 10k | 1 ±60 uV |
| | 4 | 1k | 1 ±60 uV |
| | 7 | 100Q | 1 ±60 uV |

## ERRATA #16

On page 4-1, Table 4-1:
Under EQUIPMENT NOMENCLATURE, in the STANDARD RESISTORS block,
**ADD:** 10 KQ, 0.002W

Under RECOMMENDED EQUIPMENT, in the LEEDS & NORTHRUP STDS block,
**ADD:** 4040-B

On page 4-2, para. 4-14, add the following to the end of the paragraph.

(Fluke part number 429555 for LEDS.)

On page 4-5, para. 4-27, step c,
**CHANGE:** 1K, 0.001W
**TO:** 10K, 0.002W

**ERRATA #17**

On page 4-13:
Following paragraph 4-55, add,

NOTE

Prior to this test, verify that the meter is resting at zero with the power off. If not, adjust the mechanical zero adjustment on the meter face for zero indication.

On step c,
CHANGE: ... +/-10vdc ...
TO: ... +/-20vdc ...

On page 4-14, replace Table 4-10, with Table 2.

**Table 2.**

| NOMINAL CURRENT | CURRENT LIMIT | LIMIT TOLERANCE (MA) |
|---|---|---|
| 80.00000 | 80% (8) | 80 +/-18 mA |
| 40.00000 | 40% (4) | 40 +/-10 mA |
| 20.00000 | 20% (2) | 20 +/-6 mA |
| 10.00000 | 10% (1) | 10 +/-4 mA |

**Errata #18**

On page 4-14, change paragraph 4-60 to read:
4-60. Manual Voltage Trip Alignment

Preceeding paragraph 4-61, add the following:

4-60a. Remote Voltage Trip Alignment

If the 3330B is to be operated remotely, perform the following voltage trip-out adjustments:

a. Rotate A4A4R13, V TRIPOUT ADJ, fully counter-clockwise.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | OPR |
| MODE | VOLTS, 100 |
| VOLTAGE TRIP | 100 |
| VOLTAGE TRIP LEVEL | 110% (8+2+1) |
| CROWBAR | OFF |
| POLARITY | POSITIVE |
| Decade Dials | 10X.XX000 |

c. Slowly adjust A4A4R13 clockwise until the model 3330B trips to the STDBY/RESET mode. The I LIMIT/V TRIP lamp should illuminate, and the OPR lamp should go out.

d. Program the conditions in Table 4-10A, observing that the I LIMIT/V TRIP lamp illuminates within the specified tolerance.

**Table 4-10A. Remote Voltage Trip Checks**

| NOMINAL VOLTAGE | VOLTAGE TRIP | TOLERANCE (VOLTS) |
|---|---|---|
| 80.00000 | 80% (8) | 80 +/-8V |
| 40.00000 | 40% (4) | 40 +/-4V |
| 20.00000 | 20% (2) | 20 +/-4V |
| 10.00000 | 10% (1) | 10 +/-2V |

**ERRATA #19**

On page 8-10, Figure 8-8, make the following changes:

Change R20,
FROM: 1 kV RANGE
TO: 100V RANGE

Change R21,
FROM: 100V RANGE
TO: 1 kV RANGE

**CHANGE #18 - 17513**
Rev.-B, A4A3 Differential Amplifier PCB (3330B-4003)

On page 5-29, add:

R37 | RES, MF, 1/2W, 1%, 2.15K | 144733 | 1

On page 8-12, Figure 8-10, add R37 as shown in Figure 8.

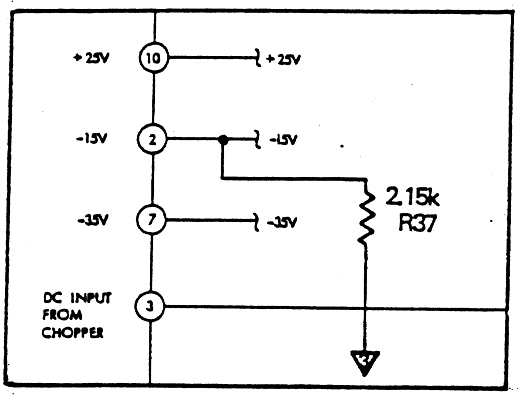



**Figure 8.**

On page 8-26 Figure 8-24, add L1 and L2 as shown in Figure 10.

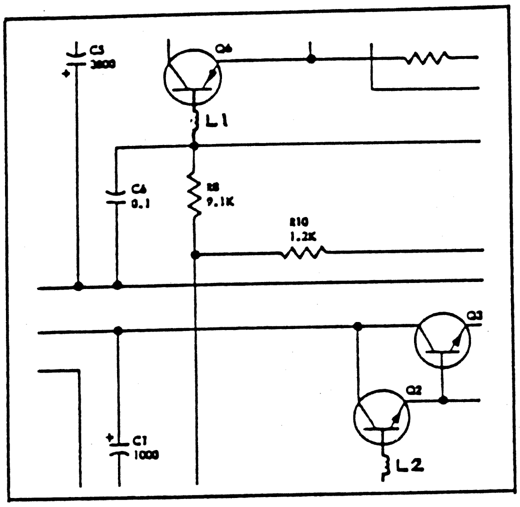



**Figure 10.**

**CHANGE #23 - 19534**
Rev.-C, A4A10 Ladder Driver No.1 Assembly (3330B-4031)

On page 5-47, make the following change:

CHANGE: K1-K4¦RELAY¦277186¦4
TO: K1-K4¦RELAY¦714097¦4

**CHANGE #24 - 19535**
Rev.-B, A4A11 Ladder Driver No.2 Assembly (3330B-4009)

On page 5-49, make the following change:

CHANGE: K1-K4¦RELAY¦277186¦4
TO: K1-K4¦RELAY¦714097¦4

**CHANGE #19 - 17850**
Rev.-D, A5A1 -25 & -5 Volt Power Supply Assembly (333B-4003)

On page 5-60, make the following changes:

DELETE: E1,E2¦Ferrite, choke core¦219535¦2

ADD: C8¦CAP, CER, .22 UF, 50V¦190314¦1

On page 8-26, Figure 8-24, delete E1 and E2 and add C8 as shown in Figure 9.

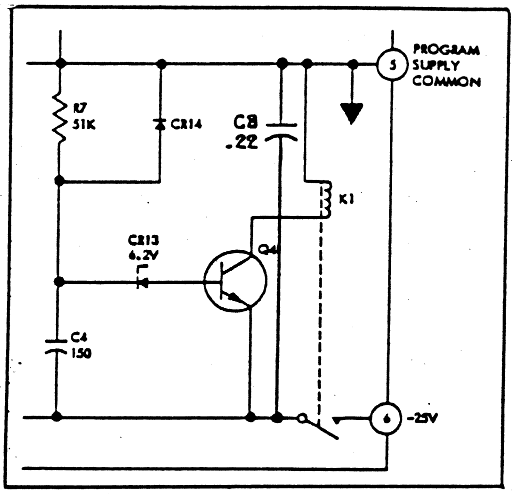



**Figure 9.**

**CHANGE #20 - 12871,13558**

On page 5-3, make the following change:

CHANGE: A4¦Main Mother Board Assembly (3330B-4001)¦285460¦1
TO: A4¦Main Mother Board Assembly (3330B-4010)¦528067¦1

**CHANGE #21 - 18652**
Rev.-C, A3 Front Mother Board Assembly (3330B-4008)

On page 5-11, make the following change:

CHANGE: Q4 thru Q13,Q16,Q17,Q18¦Tstr,silicon,PNP¦266015¦13¦2
TO: Q4 thru Q13,Q16,Q17,Q18¦Tstr,silicon,PHP¦266619¦13¦2

**CHANGE #22 - 18923**
Rev.-E, A5A1 -25 & -5 Volt Power Supply Assembly (333A-4003)

On page 5-60, add the following:

L1,L2¦Ferrite tube¦219535¦2

# Table of Contents

# List of Illustrations

# ist of Tables

Section 1

# Introduction & Specifications

## 1-1. INTRODUCTION

1-2. The Model 3330B Programmable Constant Current-Constant Voltage Calibrator is a dc calibration instrument which produces output currents from 0 to 111.11110 milliamperes and output voltages from 0 to 1111.1110 volts dc. Output current selection is provided in three ranges and is accurate to within 0.006% of the selected range. Output voltage selection is also available in three ranges with accuracies as stated in paragraph 1-6. Over current and voltage protection features are also provided, thus preventing harm from occuring to devices being tested with this instrument.

1-3. Front panel indicators provide visual indication of the output current or voltage and the operating modes of the instrument. In-line decade dials and a panel meter indicate the magnitude of the selected output. Indicator lamps provide visual indication of the various operating modes.

1-4. Systems capability is enhanced by remote control of most operating features. Remote operation is possible through the rear panel Remote connector using either contact closures or DTL/TTL logic. Programming coding requirements are binary 8-4-2-1.

1-5. The instrument is completely solid-state in design, and module plug-in construction is used for ease in maintenance. The instrument is designed for bench-top use or installation in a 19-inch electronic equipment rack. The chassis is also drilled to accept rack mounting slides.

## 1-6. SPECIFICATIONS

### 1-7. Constant Voltage Mode

ANALOG OUTPUTS

10V Range - 0 to 11.111110 volts dc (1 uv steps)
100V Range - 0 to 111.11110 volts dc (10 uv steps)
1000V Range - 0 to 1111.1110 volts dc (100 uv steps)

ACCURACY OF OUTPUT:
(% of Programmed Level)

10V range - ±0.003% or ±30 uv
100V range - ±0.003% or ±300 uv
1000V range - ±0.003% or ±3 mv

*NOTE: Above accuracies apply for 90 days at standard reference conditions of 23°C ±1°C (nominal calibration temperature, constant line voltage, up to 70% relative humidity, and constant external load.) With uninterrupted operation for more than one hour at loads greater than 25 mA, the specified accuracy is ±0.005% over an operating temperature range of 23°C ±5°C.*

OUTPUT CURRENT:

10V and 100V Ranges - 0 to 100 milliamperes at any programmed level.
1000V Range - 0 to 50 milliamperes at any programmed level.

TEMPERATURE COEFFICIENT OF OUTPUT:

Less than 4 ppm of programmed level or 0.4 ppm of range/°C.

STABILITY OF OUTPUT:

10V Range - 5 ppm of output or 10 uv/day
15 ppm of output or 30 uv/month

100V Range - 5 ppm of output or 100 uv/day
15 ppm of output or 300 uv/month

1000V Range - 5 ppm of output or 1 mv/day
15 ppm of output or 3 mv/month

*NOTE*

*Stabilities apply at standard conditions described under accuracy of output.*

RIPPLE AND NOISE:

| | UP TO 50 MA LOAD | UP TO 100 MA LOAD |
|---|---|---|
| 10V Range | 60 uv rms | 100 uv rms |
| 100V Range | 70 uv | 100 uv |
| 1000V Range | 100 uv | Not applicable |

LINE/LOAD REGULATION:

5 ppm of programmed level or 2 ppm of range for combined 10% line voltage and full-load changes.

### Constant Current Mode

ANALOG OUTPUTS:

1 MA Range - 0 to 1.1111110 ma (0.1 na steps)
10 MA Range - 0 to 11.111110 ma (1 na steps)
100 MA Range - 0 to 111.11110 ma (10 na steps)

ACCURACY OF OUTPUT:

±0.006% of programmed level, or ±0.0006% of current range.

*NOTE*

*Accuracy applies for 90 days at standard reference conditions described under constant voltage mode.*

'EMPERATURE COEFFICIENT OF OUTPUT:

Less than 6 ppm of programmed level or .4 ppm of range/°C.

STABILITY OF OUTPUT:

10 ppm of programmed level or 1 ppm of range/day.

30 ppm of programmed level or 6 ppm of range/month.

*NOTE*

Stabilities apply at standard conditions described under constant voltage mode.

COMPLIANCE VOLTAGE:

1 ma and 10 ma Ranges - up to 1000V
100 ma Range - up to 500V
(See voltage limit)

RIPPLE AND NOISE:

For negative ground or floating operation.

| MA RANGE | RIPPLE |
|---|---|
| 1 MA | 20 na |
| 10 MA | 100 na |
| 100 MA | 1 ua |

LOAD REGULATION:

1 MA Range - 2 ppm of range per 100V compliance
10 MA Range - 5 ppm of range
100 MA Range - 5 ppm of range

## 1-9. General Specifications

CURRENT LIMIT (voltage or current operation):

Remote mode - Programmable in 12 steps from 1.0 to 110 ma. (see input/output table)
Local mode - Continuously adjustable from 1 ma to 110 ma.

*NOTE*

*Limit indication by contact closure (see input/output table), and front panel lamp.*

VOLTAGE TRIP (voltage or current operation):

Remote mode - Programmable in 10% steps from 10% to 110% of trip range (see input/output table)

Local mode - Can be calibrated to be continuously adjustable from 10% to 110% of range (see Voltage Trip-calibration procedure).

*NOTE*

*In the constant current mode, the actual absolute trip voltage is decreased by the following:*

$$10 \times \frac{\text{Output Current}}{\text{Output Current Range}} \text{ Volts}$$

*NOTE*

*Output goes to zero and unit returns to standby if trip point is exceeded. Limit indication by contact closure (see Table 1-1) and front panel lamp.*

ISOLATION:

Programming lines are isolated from output. Output is isolated and guarded from chassis. Potential between programming lines and either side of output should not exceed 1150V.

METER:

For local operation, switch selectabel to indicate 0 to 1100 VDC or 0 to 110 ma.

PROGRAMMING INPUTS/OUTPUTS:

All inputs/outputs through a 50 pin rear panel connector. Mating connector furnished with instrument. See Table 1-1 for line functions.

OUTPUT CONNECTIONS:

Separate output and sense terminals provided for four-terminal connection to the load. All front

Table 1-1. PROGRAMMING INPUTS AND OUTPUTS

| INPUTS | LINES | CODING | INPUTS | LINES | CODING |
|---|---|---|---|---|---|
| | | Logic "0" = +4.5 to +20V or open circuit<br>Logic "1" = 0 to +0.5V or closed circuit | | | 40 = 0100<br>50 = 0101<br>60 = 0110<br>70 = 0111<br>80 = 1000<br>90 = 1001<br>100 = 1010<br>110 = 1011 |
| STANDBY<br>OPERATE | 1 | STANDBY = "0"<br>OPERATE = "1" | | | |
| MODE | 1 | VOLTAGE = "0"<br>CURRENT = "1" | VOLTAGE TRIP: | | |
| RANGE | 2 | CODE | VOLTAGE TRIP RANGE | 2 | CODE |
| 10V or 1 MA | | "00" (Code "11" not allowed) | 10V TRIP RANGE | | 00 |
| 100V or 10 MA | | "01" | 100V TRIP RANGE | | 01 (Code "11" Not Allowed) |
| 1000V or 100MA | | "10" | 1000V TRIP RANGE | | 10 |
| OUTPUT LEVEL<br>(7 Decades) | 28 | DECADE CODING<br>DIGIT 8421<br>0 = 0000<br>1 = 0001<br>2 = 0010<br>3 = 0011<br>4 = 0100<br>5 = 0101<br>6 = 0110<br>7 = 0111<br>8 = 1000<br>9 = 1001<br>10 = 1010 | REMOTE TRIP LEVEL (10% to 110% of selected range) | 4 | CODING<br>RANGE % 8421<br><1% = 0000<br>10% = 0001<br>20% = 0010<br>30% = 0011<br>40% = 0100<br>50% = 0101<br>60% = 0110<br>70% = 0111<br>80% = 1000<br>90% = 1001<br>100% = 1010<br>110% = 1011 |
| VOLTAGE TRIP/<br>CURRENT LIMIT: | | | POLARITY | 1 | (+) = "0"<br>(–) = "1" |
| LOCAL/REMOTE | 1 | LOCAL = "0"<br>REMOTE = "1" | CROWBAR | 1 | OFF = "0"<br>ON = "1" |
| CURRENT LIMIT: | | | OPERATE FLAG OUTPUT | 1 | CONTACTS CLOSED IN OPERATE MODE |
| REMOTE LIMIT LEVEL | 4 | CODING<br>MA 8421<br>1.0 = 0000<br>10 = 0001<br>20 = 0010<br>30 = 0011 | CURRENT LIMIT FLAG OUTPUT | 1 | CONTACTS OPEN IN NORMAL OPERATION |
| | | | VOLTAGE TRIP FLAG | 1 | CONTACTS OPEN IN NORMAL OPERATION |

panel output, guard, and chassis connections are duplicated on the rear panel.

OPERATION:

Local via front panel controls or remote via program input; selectable at front panel.

RESPONSE TIME:

1, 10, 100 ma Ranges - 300 milliseconds typical - dependent on load resistance.
10V Range - 60 milliseconds.
100V Range - 300 milliseconds
1000V Range - 3 seconds.

*NOTE*

*When on the 1000V range, maximum repetition rate of a sequentially programmed instruction should not exceed the time intervals contained in Figure 1-1.*

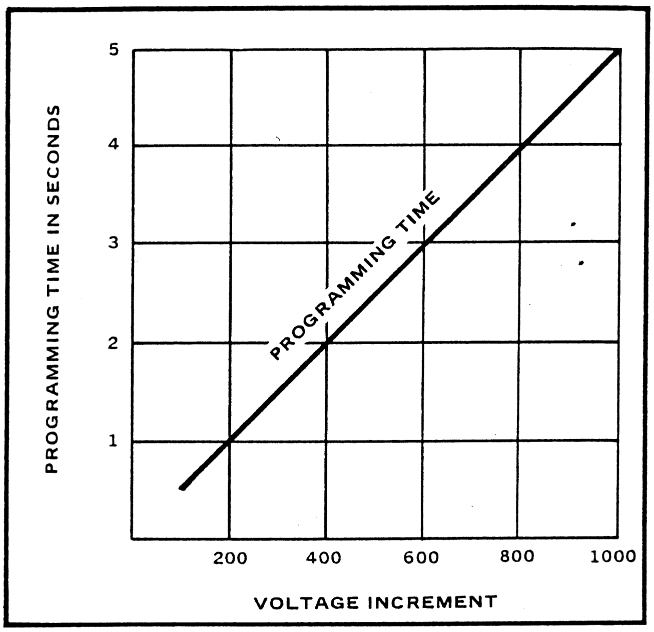



Figure 1-1. ALLOWABLE PROGRAMMING INTERVALS, 1000V RANGE AND CURRENT MODE

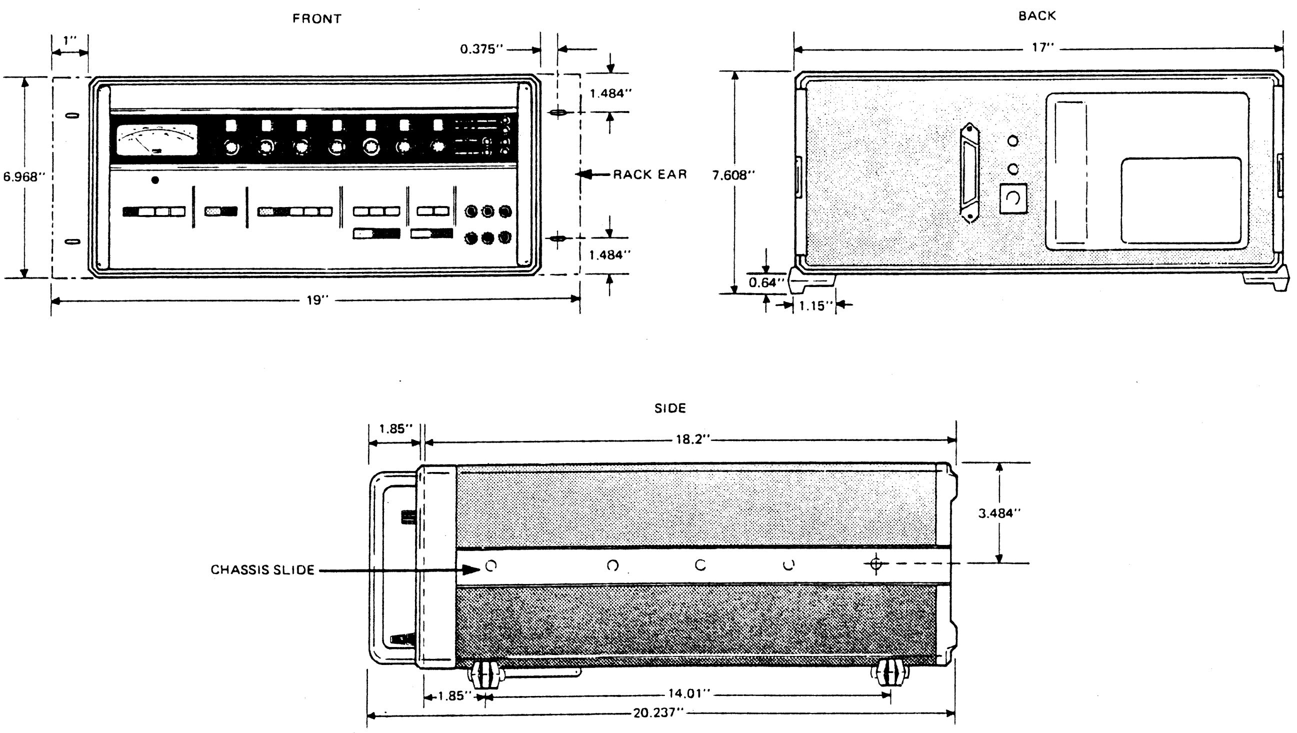



Figure 1-2. MODEL 3330B OUTLINE DRAWING

TEMPERATURE:

OPERATING - $0^{o}$ to $+50^{o}C$
NON-OPERATING - $-40^{o}C$ to $+65^{o}C$

RELATIVE HUMIDITY:

0 to 70%

SHOCK:

15 g. 11 millisecond half-sine wave (MIL-T-21200)

VIBRATION

10 Hz to 55 Hz, 3g maximum (MIL-T-21200)

ALTITUDE:

OPERATING - 0 to 10,000 ft.
NON-OPERATING - 0 to 50,000 feet

INPUT POWER:

115/230 VAC ±10%, 48 to 62 Hz single phase at approximately 130 VA fully loaded.

SIZE:

7" high x 17" wide x 18" deep

WEIGHT:

58 pounds

MOUNTING:

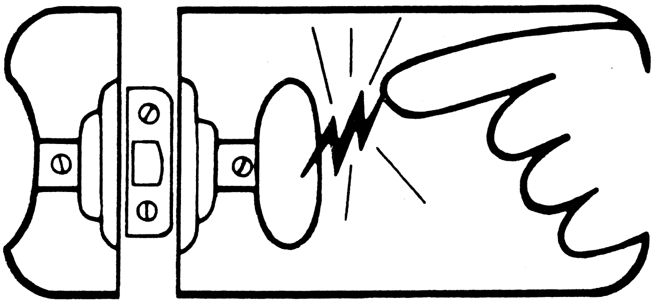
Bench: Self-supported or included custom-designed feet.

Rack: Accepts optional brackets MEE-7003 for 19" rack mounting and optional 18" chassis slides MEE-8078 (24" slides also available).

# static awareness

A Message From

**John Fluke Mfg. Co., Inc.**



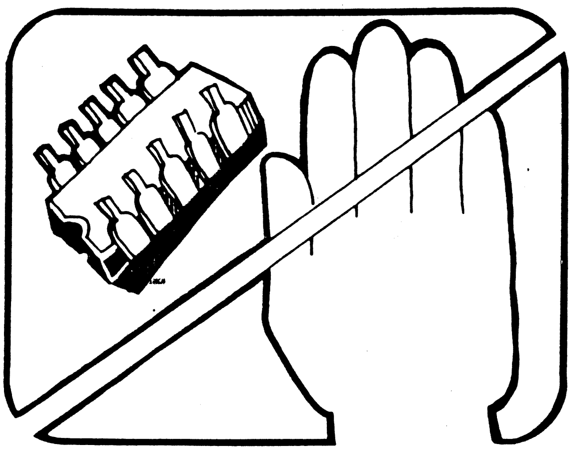
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

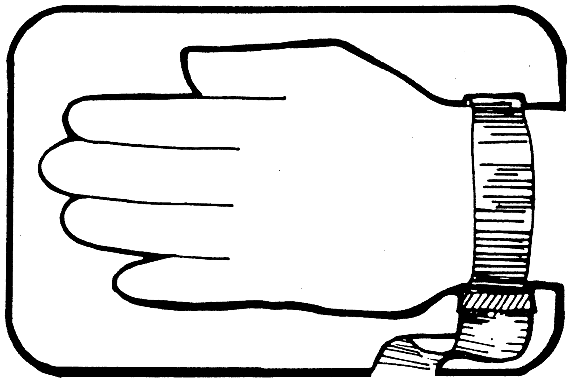
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol

" ⊗ "

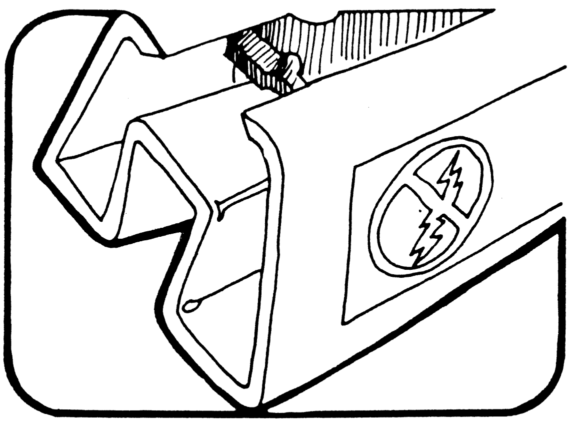
The following practices should be followed to minimize damage to S.S. devices.



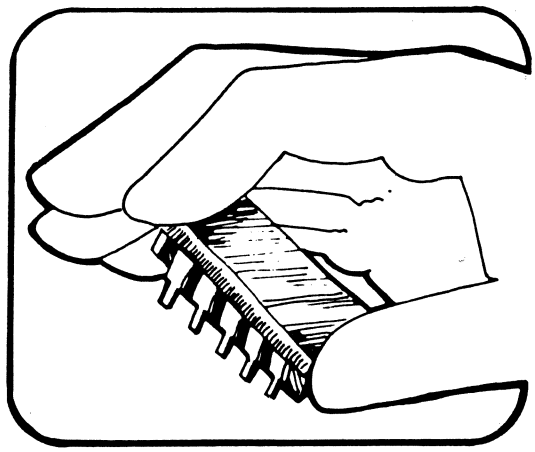
1. MINIMIZE HANDLING



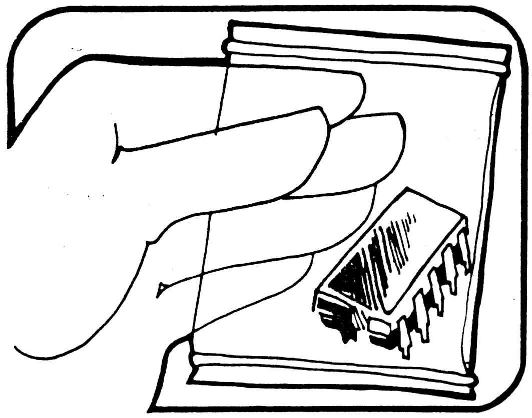
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



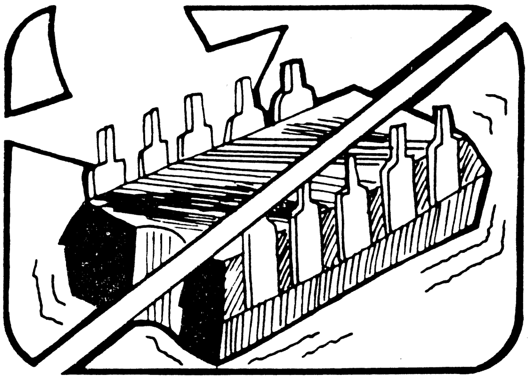
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



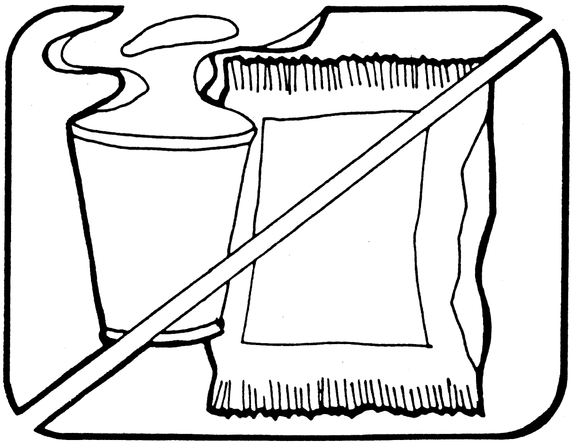
4. HANDLE S.S. DEVICES BY THE BODY



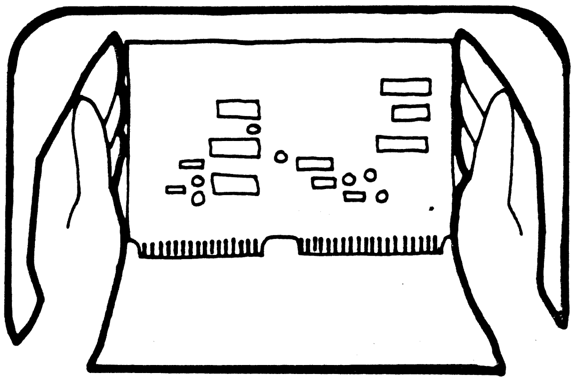
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



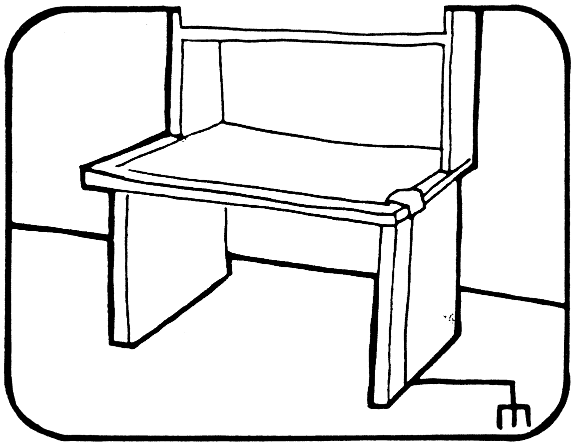
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

---

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204



® Dow Chemical



J0089D-07U8604/SE EN Litho in U.S.A.
Rev. 1 MAR 86

Section 2

# Operating Instructions

## 2-1. INTRODUCTION

2-2. This section of the manual contains information essential to the correct operation and performance of the Model 3330B. It is recommended that the contents of this section be thoroughly read and understood before attempting to operate the instrument. Should any difficulties be encountered during the operation of your instrument, please feel free to contact the nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc., Box 43210, Mountlake Terrace, WA 98043. A complete list of Sales Representatives is located in Section 7 of this manual.

### 2-3. Claim For Damage In Shipment

2-4. The Instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to the John Fluke representative. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

### 2-5. Shipping Instructions

2-6. All John Fluke Mfg. Co., Inc. instruments should be shipped prepaid in the original packing carton. Upon request, a new carton can be obtained from the John Fluke Mfg. Co., Please include the instrument model number when requesting a new container.

## 2-7. RACK MOUNTING PROCEDURES

2-8. Accessory kits are available to provide for installation of the instrument in rack or sliding mounts.

2-9. To install the rack mounting ears (MEE-7003), perform the following steps in conjunction with Figure 2-1.

a. Remove the four molded feet and the bail from the bottom cover.

b. Remove the nameplate decals from the corner castings.

c. Remove the screws from the corner castings that match the hole pattern in the rack mounting ears.

d. Attach the rack mounting ears with pan head screws.

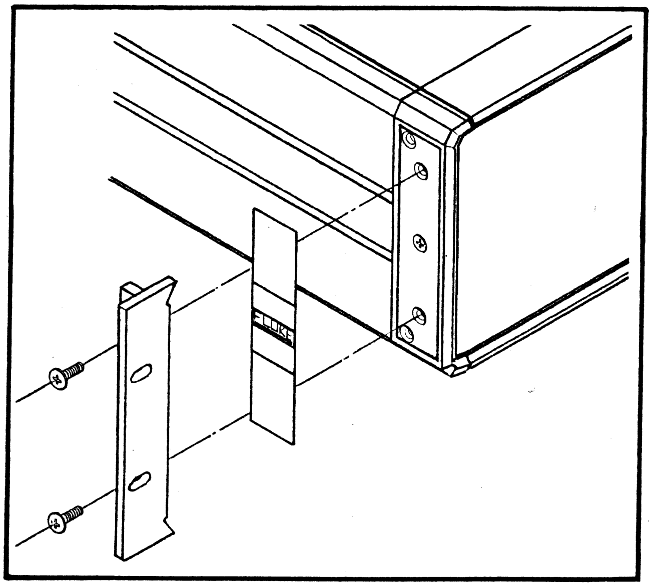


Figure 2-1. INSTALLATION OF RACK MOUNTING EARS

2-10. Perform the following steps to install the slide mounts (MEE-8078). Refer to Figure 2-2.

a. Remove the plastic trim strips (A) from the side of the instrument by sliding it towards the rear.

b. Attach the chassis section (B) of the slide and spacer strip (C) to the instrument using the center low mounting holes.

c. Install cabinet section (E) and center section (D) of slide into rack. The extension angle bracket is provided.

d. Extend center section (D) of slide towards you until it locks in the extended position.

e. Depress the spring lock on chassis section (B) and insert the instrument between the extended slide sections.

## 2-11. INPUT POWER

2-12. The Model 3330B can be operated from either a 115 or 230 volt ac input. To convert from 115 to 230 VAC or vice versa, perform the following steps:

a. Ensure that the line cord is disconnected from line power and then remove the top and bottom dust covers.

b. Remove the jumpers between terminals 1 and 2, 3 and 4, or 2 and 3 of the input power transformer located on the bottom of the instrument. A decal located on the top of the transformer indicates location of the terminals. Refer to the illustrated parts list for location of the input power transformer.

c. Make the following connections between the appropriate terminals of the power transformer:

| 115 VOLTS AC | 230 VOLTS AC |
|---|---|
| Terminals 1 and 2 | Terminals 2 and 3 |
| Terminals 3 and 4 | |

d. Replace the dust covers and install the following rated fuse in the rear panel fuseholder, F2:

| 115 VOLTS AC | 230 VOLTS AC |
|---|---|
| 3A, SLO-BLO | 1.5A, SLO-BLO |

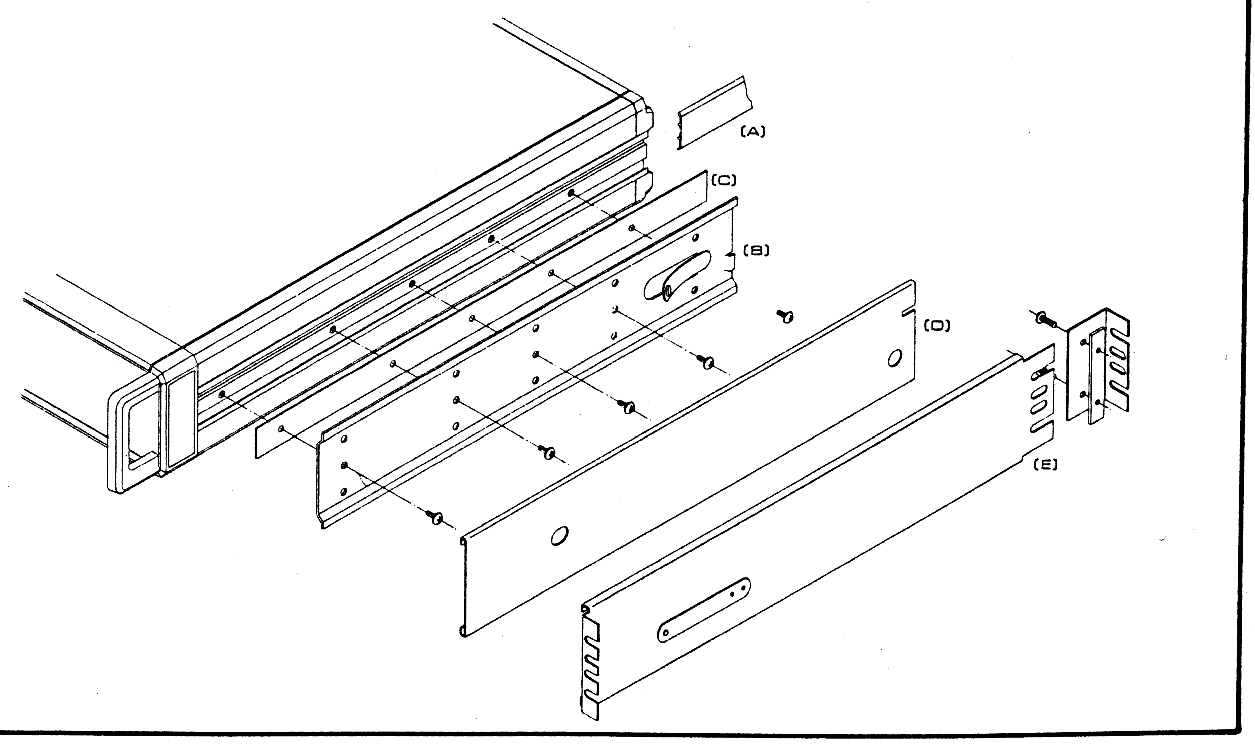



Figure 2-2. INSTALLATION OF SLIDE MOUNT

**DECADE DIALS**
Rotary dials used to select the desired output current or voltage from the instrument.

**1/10**
Selects the 1.0 milliampere or 10 volt output range.
**10/100**
Selects the 10 milliampere or 100 volt output range.
**100/1000**
Selects the 100 milliampere or 1000 volt output range.

**MA or VOLTS**
When depressed, selects the current or voltage mode of operation.

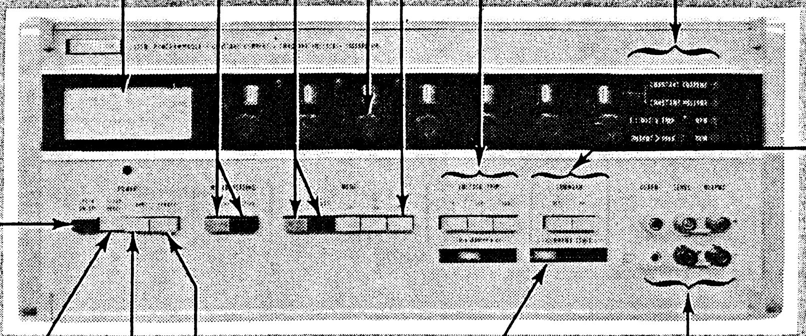
**VOLTAGE TRIP**

| | |
|---|---|
| 10 | Selects the 0 to 11 output voltage trip range. |
| 100 | Selects the 0 to 110 output voltage trip range. |
| 1000 | Selects the 0 to 1100 output voltage trip range. |
| VERNIER | Slide switch used to select 1% to 110% of the voltage trip range. |

**METER READING**
**CURRENT or VOLTAGE**
When depressed, the front panel meter indicates the output current or voltage of the instrument.

**METER**
Indicates either the selected output current or voltage present at the OUTPUT terminals.

**INDICATOR LAMPS**
Indicate current or voltage mode, current limit/voltage trip, operate mode, remote mode, and output voltage level.



**CROWBAR**
**OFF — ON**
When activated, places a 5.1 ohm load across the OUTPUT terminals to allow setting of the current limit, or limits the compliance voltage when changing loads on the current mode.

**ON – OFF**
When depressed, energizes the instrument.

**STDBY RESET**
When depressed, ac power is applied to the Auxiliary circuits only, thus preventing any output from the instrument.

**GUARD Terminal**
Provides a means of eliminating circulating ground currents through the load when properly connected.

**SENSE Terminal**
Allows the regulating circuitry within the instrument to be connected directly to the OUTPUT terminals or the load.

**OUTPUT Terminals**
Provides connection of the instrument output to the load.

**OPR**
When depressed, the selected output current or voltage is available at the OUTPUT connectors.

**REMOTE**
Transfers operating control functions to the rear panel Remote connector.

**CURRENT LIMIT**
Slide switch used to select the 1.0 to 110 milliampere output current limit point.

**REAR PANEL TERMINALS, FUSES, AND CONNECTOR (not shown)**
**TERMINALS**
Terminals connected in parallel with the front panel GUARD, SENSE, and OUTPUT terminals.
**F1**
Protects the programming circuitry from overloads.
**F2**
Protects the ac input circuitry from overloads.
**REMOTE CONNECTOR**
Provides connection to remote programming equipment. Programming commands applied to this connector are in effect when the front panel REMOTE switch is depressed.

Figure 2-3. LOCATION OF CONTROLS, TERMINALS, AND INDICATORS

## 2-13. OPERATING FEATURES

2-14. Location and function of all controls, terminals, indicators, fuses, and connectors are contained in Figure 2-3.

## 2-15. PRELIMINARY PROCEDURES

2-16. The following paragraphs describe preliminary equipment connections, control settings, and safety precautions which should be taken before attempting to operate the Model 3330B.

### 2-17. AC Line Connection

a. Connect the Model 3330B line cord to a 115 volt ac (230 volts ac, if so wired), 48 to 62 Hz, single phase three-wire outlet.

**WARNING**

**Ensure that the round pin on the three-prong line cord plug is connected to a high quality earth ground.**

b. Depress the ON-OFF and STDBY RESET switches.

### 2-18. Sense Terminal Connections

2-19. Whenever a load is connected to the Model 3330B there may be an appreciable voltage drop between the instrument and the load due to the resistance of the connecting cable leads. The nomograph illustrated in Figure 2-4 can be used to determine the approximate voltage drop within the connecting cable. If the voltage drop is excessive for the particular application, the instrument can be connected for remote sensing using the procedure described in paragraph 2-21.

NOTE

*On all voltage ranges, the remote sense leads operate at a current level which varies from 0 to 1 mA in proportion to the output voltage. Voltage drops in the sense leads are additive and appear at the output as a voltage increase.*

NOTE!

*The maximum allowable differential between an OUTPUT terminal and its respective SENSE terminal is ≤0.5 V dc.*

2-20. NOMOGRAPH USE. Lay a straight edge between the point representing the output current on scale 1 and the gauge of the connecting cable on scale 2. The voltage developed across connecting cable, in millivolts per foot, is then read on scale 3. Calculate the total voltage drop by multiplying the total connecting cable length in feet by the scale 3 value. (A 5 foot cable will have a total connection length of 10 feet).

2-21. REMOTE SENSING TERMINAL CONNECTIONS.

a. Depress the STDBY RESET switch.

b. Remove the shorting links between the SENSE and OUTPUT terminals.

c. Connect the + and – SENSE terminals to the respective positive and negative sides of the load. Use a twisted pair of insulated wires between the SENSE terminals and the load.

**CAUTION**

**Ensure that the SENSE terminals are connected in proper polarity to the load or a loss in regulation or even damage to the Model 3330B may occur. IF THIS REMOTE SENSING FEATURE IS NOT USED, THE SENSE TERMINALS MUST BE CONNECTED TO THE OUTPUT TERMINALS WITH THE SHORTING LINKS.**

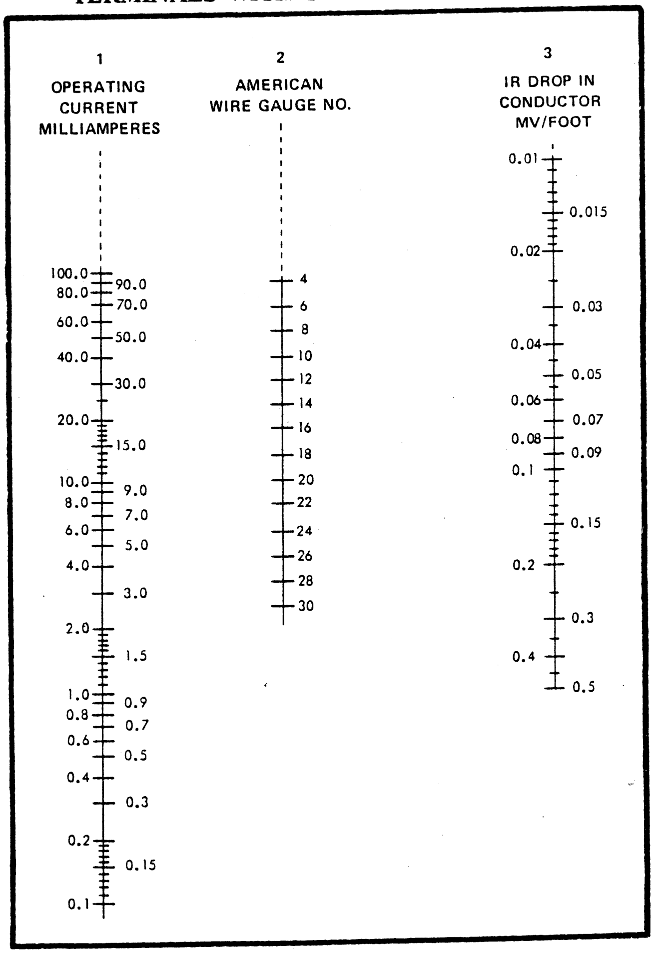



Figure 2-4. NOMOGRAPH OF VOLTAGE DROP ACROSS LOAD WIRES

## 2-22. Guarded Measurements

2-23. INTRODUCTION. When using the Model 3330B significant errors may arise out of undesired conversion of common mode signals to normal mode. This instrument has a guard shield that functions to minimize common mode-to-normal mode conversion. The following paragraphs describe errors that may arise out of common mode problems and provide a means to reduce them.

2-24. COMMON MODE REJECTION RATIO (CMRR) In non-guarded applications, a path for undesired common mode signals is created by the stray capacitance $C_1$ (Figure 2-5) representing the circuitry-to-case capacitance in the instrument. This capacitance enables frequency dependent currents to appear in the connecting leads between the instrument and load, and in the instrument circuitry itself.

2-25. The guard shield provides a means of making the circuitry-to-case capacitance very small, thereby reducing common mode currents. This is done by placing a shield, or guard, between the circuitry and case. Addition of the guard results essentially in two things; it provides a separate path for common mode signals, and it effectively prevents the introduction of common mode errors in the circuitry itself. Where common mode signals previously had a path through $C_1$ into the circuitry and connecting leads and through $R_S$, insertion of the guard now provides a separate path through $C_3$ and into the guard lead. In addition, the circuitry-to-case capacitance is significantly reduced, and the CMRR of the instrument is greatly enhanced.

2-26. SUGGESTIONS FOR USING THE GUARD. Under most applications it is satisfactory to strap the front panel GUARD to the ground terminal of the load. In applications where common mode signals are of no concern, the GUARD may be connected to the ⏚ (ground) terminal.

## 2-27. Voltage Trip Settings

2-28. The VOLTAGE TRIP switch and VERNIER controls provide protection for external equipment by limiting the maximum allowable output voltage to the external load. The range of voltage limiting is selected with the VOLTAGE TRIP switches. Refinement of the value of the voltage to be limited is accomplished with the VERNIER control.

a. Without any load connected to the OUTPUT terminals, depress the STDBY/RESET switch and set the front-panel controls to the following positions:

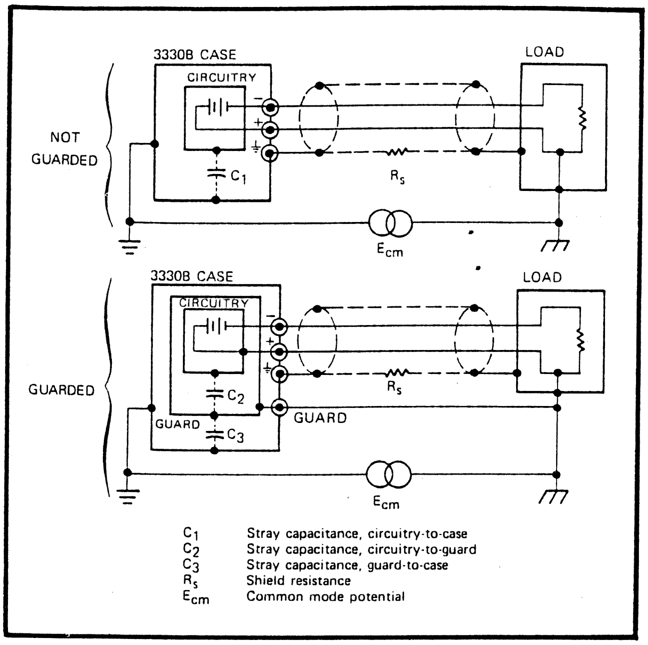



Figure 2-5. GUARDED LOAD CONNECTIONS

| | |
|---|---|
| MODE | Desired voltage range |
| VOLTAGE TRIP | To the lowest voltage range that overlaps the desired trip voltage. |
| VERNIER | HI |
| CURRENT LIMIT | As desired |
| METER | VOLTAGE |
| Decade Dials | Desired trip voltage |

b. Depress the OPR switch.

c. Slowly slide the VERNIER control to the left until the 1 LIMIT/V TRIP indicator illuminates and the OPR lamp extinguishes. The voltage trip is now set to the value indicated on the Decade Dials, and the instrument is tripped to the STDBY mode.

d. To reset the instrument, set the Decade Dials to a value less than the trip voltage, depress the STDBY/RESET switch, and then depress the OPR switch.

## 2-29. Current Limit Settings

2-30. The CURRENT LIMIT control provides a means of limiting the amount of output current applied to the load. If limiting within the output current range of the instrument is not desirable, set the CURRENT LIMIT control to HI. Should some degree of current limiting be desirable, proceed as follows:

a. Depress the STDBY RESET switch, and set the front panel controls to the following positions:

| | |
|---|---|
| MODE | Desired current (MA) range |
| VOLTAGE TRIP | As desired. However, must be >10V for full scale output current. To set a precise level, use the voltage trip setting procedure, given eralier, and set the Decade Dials to: |

Output Current
Output Current Range + desired voltage trip level

For example, at full scale current output, a precise 5V trip level is established by setting the Decade Dials to 15.

RRENT LIMIT LO
TER CURRENT
ade Dials As required

Depress the CROWBAR ON and OPR switches.

Slide the CURRENT LIMIT control to the right until the desired maximum output current is indicated on the front panel meter.

Depress the STDBY RESET switch and then depress the CROWBAR OFF switch. Current limiting is now set to the desired value for any output setting of the instrument.

## 1. FRONT PANEL OPERATING PROCEDURES.

2. The Model 3330B can be operated as a voltage current source by performing the following steps:

Depress the ON-OFF and STDBY RESET switches. Allow the instrument circuitry to stabilize for at least 10 minutes if it has not been previously energized.

Connect the SENSE terminals to the OUTPUT terminals using the shorting links provided with the instrument.

Set the Current Limit and Voltage Trip to the desired values using the procedures described in paragraphs 2-27 and 2-29.

Depress the STDBY/RESET switch and select the desired current or voltage range with the MODE switches.

Set the Decade Dials to the desired output current or voltage value.

Connect the load to the OUTPUT terminals. If remote sensing is desired, connect the SENSE terminals to the load using the procedures described in paragraph 2-21. GUARD terminal connections are described in paragraph 2-22.

WARNING

**The Model 3330B has a compliance voltage capability of 1100 volts dc. Always connect the load with the instrument in STDBY/RESET.**

g. Depress the OPR switch to energize the load. The output current or voltage can be monitored at any time on the front panel meter by depressing the appropriate METER READING switch.

## 2-33. REMOTE OPERATION

2-34. Remote programming of the Model 3330B is possible through the rear panel Remote connector using either DTL/TTL logic and 8-4-2-1 coding or contact closures. A mating connector for the remote connector is furnished with the instrument to provide the necessary circuit interface. Table 2-1 contains a list of the Remote connector terminals and their functions. Coding information is located in Section 1, Table 1-1.

Table 2-1. REMOTE CONNECTOR TERMINALS AND FUNCTIONS (Sheet 1 of 2)

| TERMINAL | FUNCTION |
|---|---|
| 1 | 1 – Highest Order Decade |
| 2 | 2 – Highest Order Decade |
| 3 | 4 – Highest Order Decade |
| 4 | 8 – Highest Order Decade |
| 5 | 1 – Second Order Decade |
| 6 | 2 – Second Order Decade |
| 7 | 4 – Second Order Decade |
| 8 | 8 – Second Order Decade |
| 9 | 1 – Third Order Decade |
| 10 | 2 – Third Order Decade |
| 11 | 4 – Third Order Decade |
| 12 | 8 – Third Order Decade |
| 13 | 1 – Fourth Order Decade |
| 14 | 2 – Fourth Order Decade |
| 15 | 4 – Fourth Order Decade |
| 16 | 8 – Fourth Order Decade |
| 17 | 1 – Fifth Order Decade |
| 18 | 2 – Fifth Order Decade |
| 19 | 4 – Fifth Order Decade |
| 20 | 8 – Fifth Order Decade |
| 21 | 1 – Sixth Order Decade |
| 22 | 2 – Sixth Order Decade |
| 23 | 4 – Sixth Order Decade |
| 24 | 8 – Sixth Order Decade |

Table 2-1. REMOTE CONNECTOR TERMINALS AND FUNCTIONS (Sheet 2 of 2)

| TERMINAL | FUNCTION |
|---|---|
| 25 | 1 – Seventh Order Decade |
| 26 | 2 – Seventh Order Decade |
| 27 | 4 – Seventh Order Decade |
| 28 | 8 – Seventh Order Decade |
| 29 | Logic "0" – 10V/1 MA Range<br>Logic "1" – 100V/10 MA Range |
| 30 | Logic "0" – Voltage Mode<br>Logic "1" – Current Mode |
| 31 | Logic "0" – 10V/1 MA or 100V/10 MA Range<br>Logic "1" – 1000V/100MA Range |
| 32 | |
| 33 | Logic "0" – Standby Mode<br>Logic "1" – Operate Mode |
| 34 | Logic "0" – Crowbar Mode Off<br>Logic "1" – Crowbar Mode On |
| 35 | Logic "0" – Positive Polarity Output<br>Logic "1" – Negative Polarity Output |
| 36 | Program Common |
| 37 | 'Operate'Flag |
| 38 | Logic "0" – Front Panel Voltage Trip and Current Limiter Control<br>Logic "1" – Remote Voltage Trip and Current Limiter Control |
| 39 | 1 – 10% Voltage Trip Vernier |
| 40 | 2 – 20% Voltage Trip Vernier |
| 41 | 4 – 40% Voltage Trip Vernier |
| 42 | 8 – 80% Voltage Trip Vernier |
| 43 | 8 – 80% – Current Limit Vernier |
| 44 | 4 – 40% – Current Limit Vernier |
| 45 | 2 – 20% – Current Limit Vernier |
| 46 | 1 – 10% – Current Limit Vernier |
| 47 | 1 KV Voltage Trip Range |
| 48 | 100V Voltage Trip Range |
| 49 | Current Limit Flag |
| 50 | Voltage Trip Flag |

2-35. Activation of the remote control feature is accomplished by first energizing the instrument while in STDBY RESET or by selecting STDBY RESET, and then selecting the REMOTE mode of operation. Control is then transferred to the rear Panel Remote connector where either transistor logic level programming or contact closures can be used to control the operating modes of the instrument. Logic "1" is 0 to 0.5 volts dc or a short circuit, and Logic "0" is +4.5 to 20 volts dc or an open circuit. Short circuit current to programming common is less than 4.0 milliamperes. Open circuit voltage is 4 to 6 volts dc.

2-36. Excessive output level changes will result in triggering of the Voltage Trip circuitry, especially on the 1000 volt range. In this event the 3330B must be manually reset using the STDBY RESET Switch. Safe programming rates are listed below. Figure 1-1 located in Section 1 shows recommended 1000V range programming rates below 1000 volts.

| | | |
|---|---|---|
| a. | 1000 volt range | 1 programming change every 5 seconds for 1000 volt change. |
| | All current ranges: | 1 programming change every 5 seconds for a 1000V change. |

2-37. Accuracy of the Model 3330B output is also affected by the magnitude of the programming changes. Figure 2-6 shows typical output accuracies in relation to 1/10th to full-scale voltage changes.

## 2-38. PROGRAMMING NOTES

### 2-39. Introduction

2-40. Successful programming of the 3330B calibrator requires knowledge of the timing involved and an awareness of control line definitions. The following paragraphs contain notes which will be of value in programming, plus timing information for proper instrument control.

### 2-41. Decade Dials

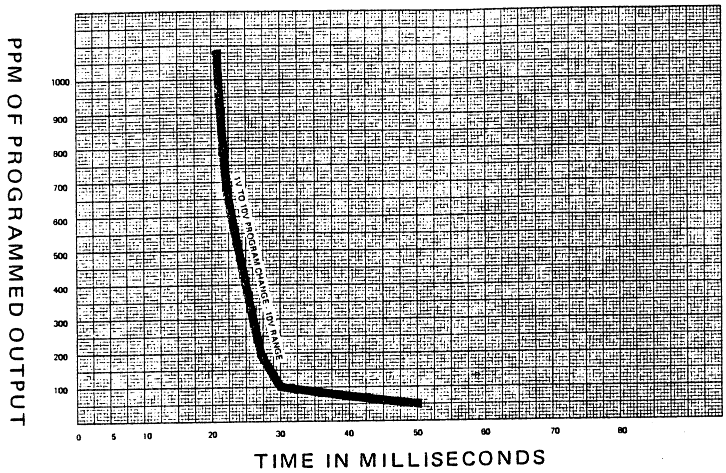
2-42. Programming of each Decade Dial is accomplished using 8-4-2-1 coding. The maximum digit that can be programmed on each decade is 10, using a "1010" code. Maximum remote controlled output is 111.11110 milliamperes and 1111.1110 volts dc.

### 2-43. Polarity

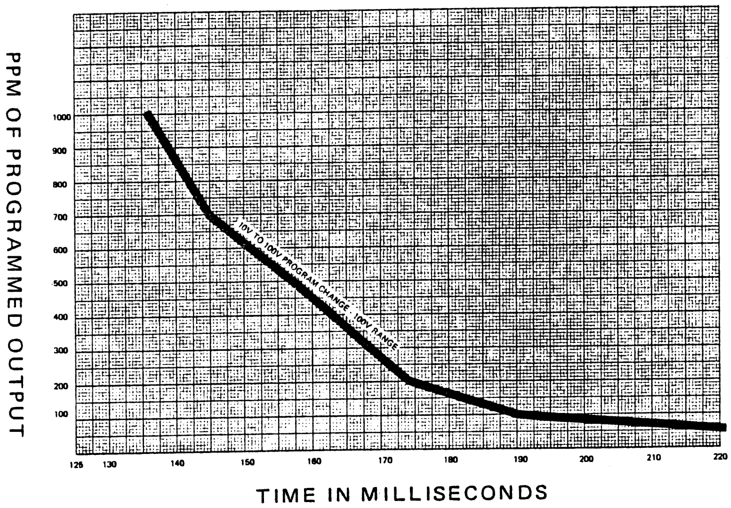
2-44. A Logic "1" applied to the proper programming terminal will reverse the output polarity at both the front and rear terminals of the instrument.

### 2-45. Voltage/Current Limit Vernier

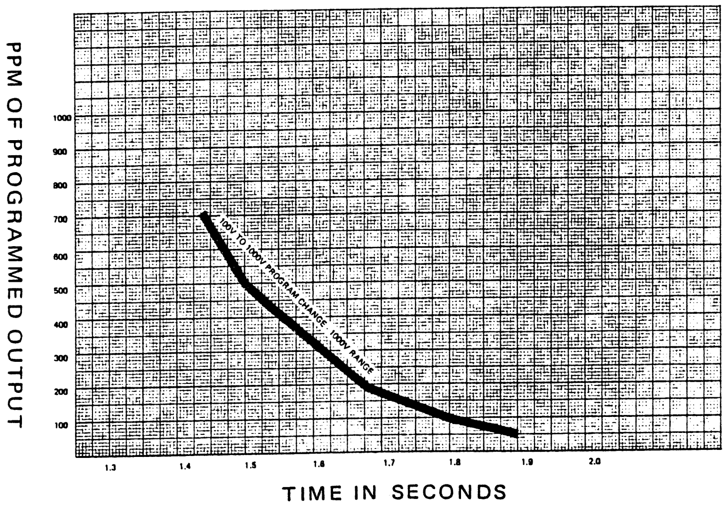
2-46. Programming of the Voltage or Current Vernier is accomplished using 8-4-2-1 coding. The minimum




OUTPUT ACCURACY FOR A 1V TO 10V PROGRAM CHANGE – 10V RANGE




OUTPUT ACCURACY FOR A 10V TO 100V PROGRAM CHANGE – 100V RANGE



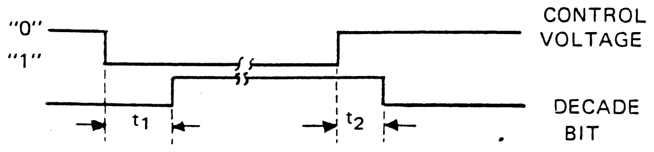

OUTPUT ACCURACY FOR A 100V TO 1000V PROGRAM CHANGE – 1000V RANGE

Figure 2-6. OUTPUT ACCURACY VERSUS PROGRAM CHANGE TIME

**DECADE PULL-IN TIME:** THE PERIOD REQUIRED TO ELECTRICALLY ADD A DECADE BIT TO THE CIRCUITRY AFTER THE PARTICULAR BIT HAS BEEN ACTIVATED BY AN EXTERNAL CONTROL VOLTAGE.

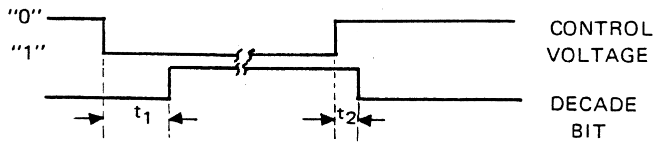
| | | |
|---|---|---|
| DECADE A | - | 15 MS |
| DECADE B & C | - | 10 MS |
| DECADE D–G | - | 2 MS |

DECADE A




PULL-IN TIME ($t_1$) = 15 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 12 ms TYPICALLY

DECADES B & C

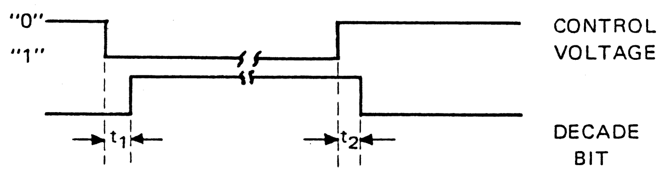



PULL-IN TIME ($t_1$) = 10 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 3 ms TYPICALLY

**DECADE DROP-OUT TIME:** THE PERIOD REQUIRED TO ELECTRICALLY DROP A PARTICULAR DECADE BIT FROM THE CIRCUITRY AFTER REMOVING ITS EXTERNAL CONTROL VOLTAGE.

| | | |
|---|---|---|
| DECADE A | - | 12 MS |
| DECADE B & C | - | 3 MS |
| DECADE D–G | - | 3 MS |

DECADES D, E, F, & G




PULL-IN TIME (t) = 2 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 3 ms TYPICALLY

**SETTLING TIME:** THE TOTAL TIME REQUIRED FOR THE INSTRUMENT TO SETTLE TO ITS RATED ACCURACY WITHIN A PARTICULAR RANGE AND MODE OF OPERATION.

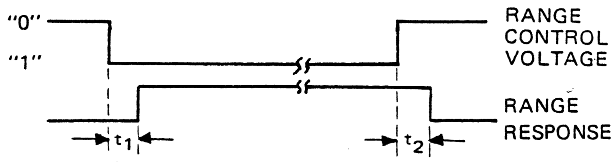
**VOLTAGE MODE:**

| | | |
|---|---|---|
| 10V RANGE | - | 60 MS |
| 100V RANGE | - | 300 MS |
| 1000V RANGE | - | 3 SEC. |

**CURRENT MODE:**

| | | |
|---|---|---|
| 1 MA RANGE | - | 300 MS |
| 10 MA RANGE | - | 300 MS |
| 100 MA RANGE | - | 300 MS |

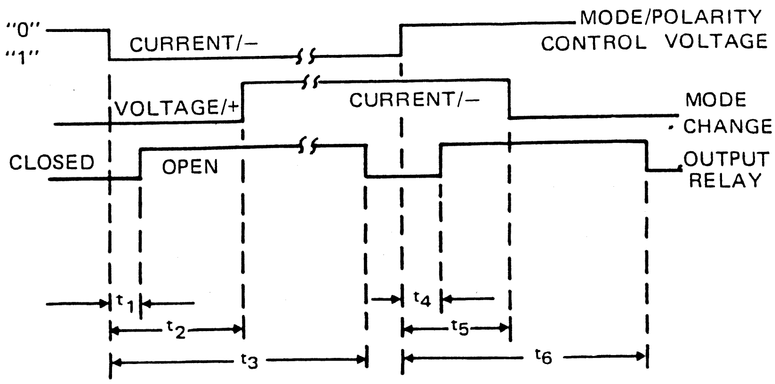
**RANGE CHANGE TIME:** THE PERIOD OF TIME BETWEEN APPLICATION OF AN EXTERNAL RANGE CONTROL VOLTAGE AND WHEN THE PARTICULAR RANGE IS ADDED ELECTRICALLY TO THE CIRCUIT (10ms).




PULL-IN TIME ($t_1$) = 15 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 5 ms TYPICALLY

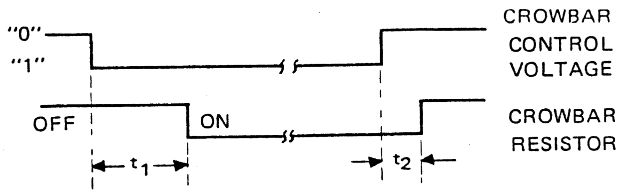
Figure 2-7. TIMING INFORMATION (Sheet 1 of 3)

**POLARITY AND MODE CHANGE TIME:** THE PERIOD OF TIME BETWEEN APPLICATION OF AN EXTERNAL CONTROL VOLTAGE AND WHEN THE OUTPUT RELAY CONTACTS REMOVE THE SHORT ACROSS THE OUTPUT TERMINALS. (See Crowbar Time) (130 ms).



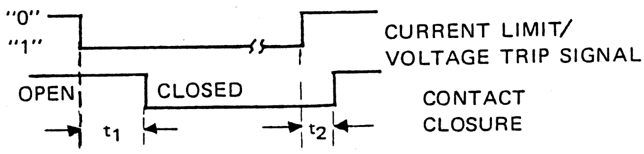

PULL-IN TIME ($t_2$) = 45 ms TYPICALLY
PULL-IN TIME ($t_3$) = 100 ms TYPICALLY
PULL-IN TIME ($t_6$) = 80 ms TYPICALLY
DROP-OUT TIME ($t_1$) = 10 ms TYPICALLY
DROP-OUT TIME ($t_4$) = 10 ms TYPICALLY
DROP-OUT TIME ($t_5$) = 50 ms TYPICALLY

**CROWBAR TIME:** THE PERIOD BETWEEN APPLICATION OF AN EXTERNAL CONTROL VOLTAGE AND WHEN THE CROWBAR RESISTOR APPEARS ELECTRICALLY ACROSS THE OUTPUT TERMINALS (15 ms).



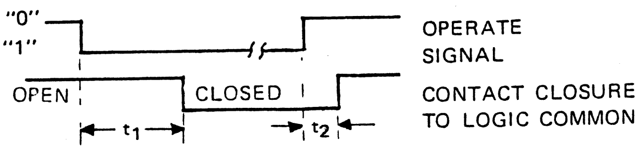

PULL-IN TIME ($t_1$) = 15 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 5 ms TYPICALLY

**CURRENT LIMIT AND VOLTAGE TRIP FLAG TIME:** THE PERIOD BETWEEN THE OVER-CURRENT OR OVER-VOLTAGE CONDITION AND A CONTACT CLOSURE TO LOGIC COMMON AT THE PROGRAMMING CONNECTOR. (2 ms).



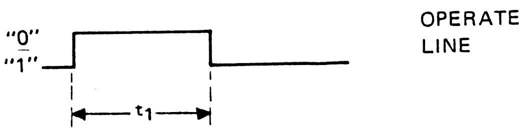

PULL-IN TIME ($t_1$) = 2 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 1 ms TYPICALLY

**OPERATE FLAG TIME:** THE PERIOD OF TIME BETWEEN DEPRESSION OF THE OPERATE SWITCH AND A CONTACT CLOSURE TO COMMON AT THE PROGRAMMING CONNECTOR. (15 ms).




PULL-IN TIME ($t_1$) = 15 ms MAXIMUM
DROP-OUT TIME ($t_2$) = 5 ms TYPICALLY

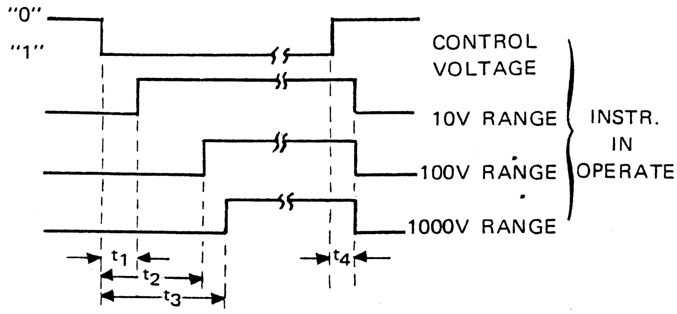
**RESET TIME:** THE PERIOD OF TIME THE "OPERATE" LINE MUST BE HELD AT LOGIC "O" IN ORDER TO ELECTRICALLY RESET THE INSTRUMENT. (10 ms). (Refer to "NOTE" of paragraph 2-54).




MINIMUM RESET TIME ($t_1$) = 10 ms TYPICALLY

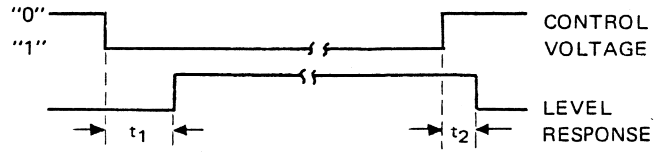
Figure 2-7. TIMING INFORMATION (Sheet 2 of 3)

**OPERATE TIME:** THE PERIOD BETWEEN APPLICATION OF AN EXTERNAL CONTROL VOLTAGE AND WHEN THE PROGRAMMED OUTPUT IS WITHIN SPECIFICATIONS. (1 Sec to 3.5 sec. depending on Range).



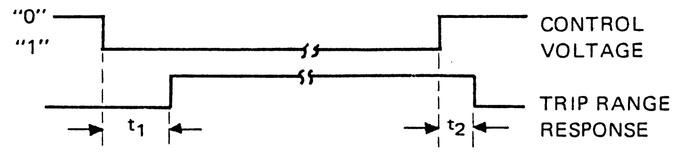

10V RANGE, 10V OUT ($t_1$) = 1 sec. TYPICALLY
100V RANGE, 100V OUT ($t_2$) = 3 sec. TYPICALLY
1000V RANGE, 1000V OUT ($t_3$) = 3.5 sec. TYPICALLY
ALL RANGES, OUTPUT DE-ENERGIZED ($t_4$) = 10 ms.

**CURRENT LIMIT/VOLTAGE TRIP LEVEL TIME:** THE PERIOD BETWEEN APPLICATION OF AN EXTERNAL CONTROL VOLTAGE AND WHEN THAT PARTICULAR LEVEL IS ADDED ELECTRICALLY TO THE CIRCUIT. (2 ms).




PULL-IN TIME ($t_1$) = 2 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 1 ms TYPICALLY

**VOLTAGE TRIP RANGE TIME:** THE PERIOD BETWEEN APPLICATION OF AN EXTERNAL CONTROL VOLTAGE AND WHEN THE PARTICULAR VOLTAGE TRIP RANGE IS ADDED ELECTRICALLY TO THE CIRCUIT. (2 ms).




PULL-IN TIME ($t_1$) = 2 ms TYPICALLY
DROP-OUT TIME ($t_2$) = 1 ms TYPICALLY

Figure 2-7. TIMING INFORMATION (Sheet 3 of 3)

vernier voltage or current limit value that can be programmed is 10% of the selected range using a "0001" code. Maximum vernier limit value is 110% of the selected range using a "1011" code.

## 2-47. Voltage Trip Range

2-48. Programming of the Voltage Trip Range may be accomplished by applying Logic "1" to the proper programming terminals. The Voltage Trip is normally in the 10V range with program lines at Logic "0". Whenever the Voltage Trip Feature is triggered, the instrument is automatically tripped to the STDBY/RESET mode. Logic "0" must then be applied to terminal 33, followed by Logic "1" to return the instrument to OPERATE. Refer to paragraph 2-54 for resetting information.

## 2-49. Flag Indicator Outputs

2-50. Isolated flag indicator outputs are available at the Remote connector to provide an indication of the Operate/Voltage Trip, or Current Limit modes of operation. Terminal 50 is the Voltage Trip Flag, terminal 49 is the Current Limit Flag, and terminal 37 is the Operate Flag. If a polarity or mode change is programmed, a standby state will be indicated for approximately 100 milliseconds. Each flag is a contact closure to terminal 36, Program Common.

## 2-51. Timing Information

2-52. Figure 2-7 contains timing definitions and waveforms which will be of assistance in programming the Model

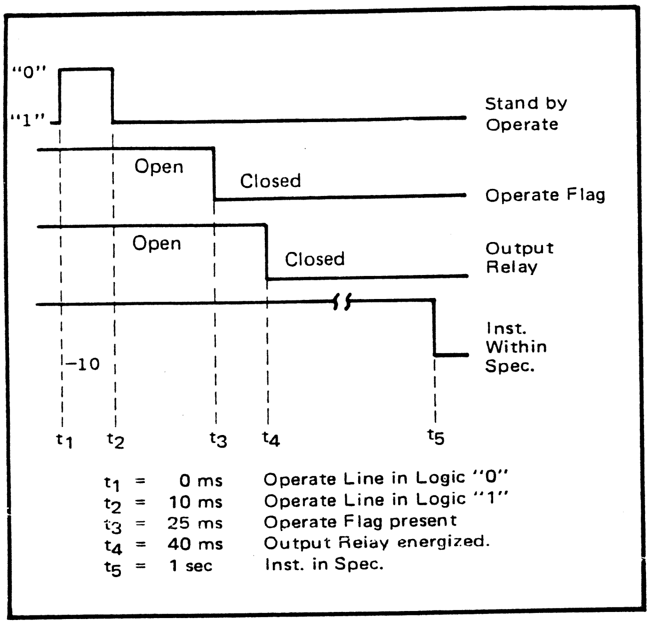



Figure 2-8. TYPICAL RESET ON 10V RANGE

3330B. Pay particular attention also to the special operating considerations outlined in paragraph 2-53.

## 2-53. Special Operating Conditions

2-54. RESETTING. The operate line must be held in a Logic "0" state for a minimum of 10 ms before Logic "1" may be applied. Actual resetting is accomplished as soon as the operate line is returned to Logic "0". When a Logic "1" is applied, the output becomes energized.

*NOTE*

*Resetting is not possible for a period of five seconds if the instrument is in a voltage trip condition due to excessive application of the automatic crowbar. Refer to paragraphs 3-70 and 3-74.*

2-55. CURRENT MODE. When switching from low to high compliance voltages, programming speeds must be slower. This applies when using compliance voltages in excess of 200 volts; programming rates should not exceed the times shown in Figure 1-1, Section I.

2-56. VOLTAGE MODE. Range or programming changes within the 1 kv range must be made at rates within the times shown in Figure 1-1; this applies when output voltages are greater than 200 volts.

2-57. CURRENT LIMIT/VOLTAGE TRIP FLAGS. The current and voltage flags will not be enabled and consequently cannot be present at the programming connector until approximately 40 ms after the instrument is in the operate mode. Also, there will be an absence of both flags for approximately 100 ms during either a mode or polarity change, due to the instrument being placed in standby during this time.

2-58. **OPERATE FLAG.** A contact closure to program common will be present approximately 15 ms after the instrument is commanded to the operate mode. The output relay does not energize for another 15 ms; see Figure 2-8. During a polarity or mode change, the output relay will open for 100 ms and then close.

2-59. VOLTAGE TRIP RANGE. When programming the Output Voltage and Voltage Trip range from some high level to a low level, it must be remembered that the Voltage Trip Range time is much less than the Output Voltage settling time. If both are programmed down simultaneously, the instrument will trip into the Voltage Trip mode. Allow sufficient time after programming the output from a high level to a low level before programming the Voltage Trip Range from a high level to a low level. In a worst-case application, with the instrument operating on the 1000 volt range, if all the decades are

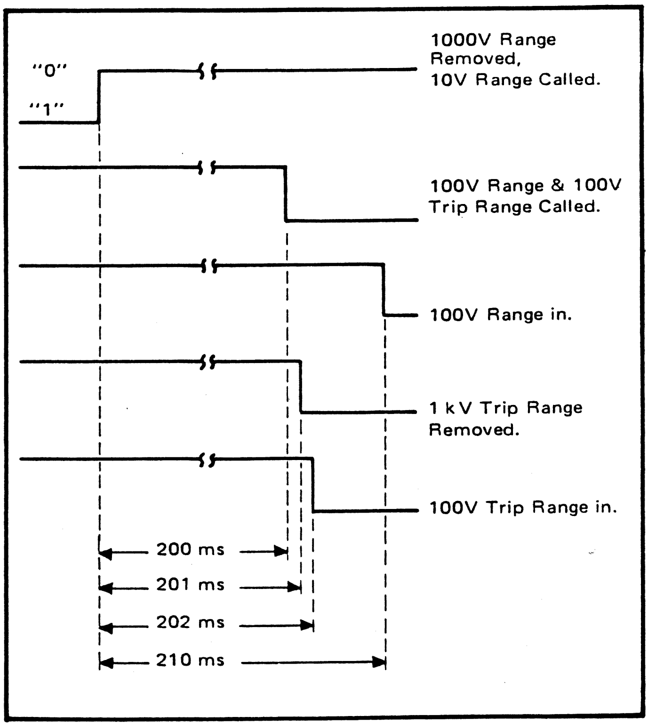



Figure 2-9. 1 KV to 100V TRIP TIMING

programmed to zero, allow 3 seconds before programming the Voltage Trip Range to a lower range.

2-60. To program the Voltage Trip Range from the 1000V range to the 100V range, first down-range the instruments' output to the 10V range. Then, 200 ms after the instrument has been down-ranged, program the 100V range and the 100V Voltage Trip Range simultaneously. Refer to Figure 2-9.

## 2-61. Operating Examples

2-62. The use of an output crowbar when using the current mode is normal procedure, since the crowbar is used when changing loads in the current mode. As pointed out in Figure 2-7, 15 ms is required before the crowbar actuates. Therefore, 15 ms of time is required before removing or changing loads. If this procedure is not followed, the instrument will slew up to the voltage trip point.

# Section 3
# Theory of Operation

## 3-1. INTRODUCTION

3-2. This section of the manual contains the theory of operation for the Model 3330B. The information is arranged under headings of "ASSEMBLY NUMBERING SYSTEM, FUNDAMENTAL CIRCUIT DESCRIPTION, GENERAL CIRCUIT ANALYSIS, and CIRCUIT DESCRIPTIONS". An equivalent circuit of the instrument is illustrated in Figure 3-2. A system block diagram and schematic diagrams are located in Section 8 of the manual.

## 3-3. ASSEMBLY NUMBERING SYSTEM.

### 3-4. General

3-5. The following assembly numbering system has been employed in the Model 3330B to identify specific assemblies and their electrical components.

### 3-6. Assembly Reference Designations.

3-7. The Model 3330B is divided into major parent assemblies designated the letter number A1 through A7. These assemblies and their respective titles are:

| | |
|---|---|
| A1 | Front Panel |
| A2 | Rear Panel |
| A3 | Front Mother Board |
| A4 | Main Mother Board |
| A5 | Rear Mother Board |
| A6 | Relay Board |
| A7 | Inner Chassis |

3-8. Assemblies contained within major assemblies are also identified by a letter number designation. For example, the Chopper Amplifier located on the A4 Main Mother Board has been assigned the letter number A2. Complete identification of this assembly is A4A2.

3-9. Components located on each assembly are designated the appropriate letter number Q1, C1, R1, etc. For example, the MOS FET transistor on the Chopper Amplifier is designated the letter number Q1. Complete identification of a component is then possible by preceding its reference designation by the assembly designation. In the preceding example, Q1 is completely identified by the designation A4A2Q1.

### 3-10. Assembly Identifiers

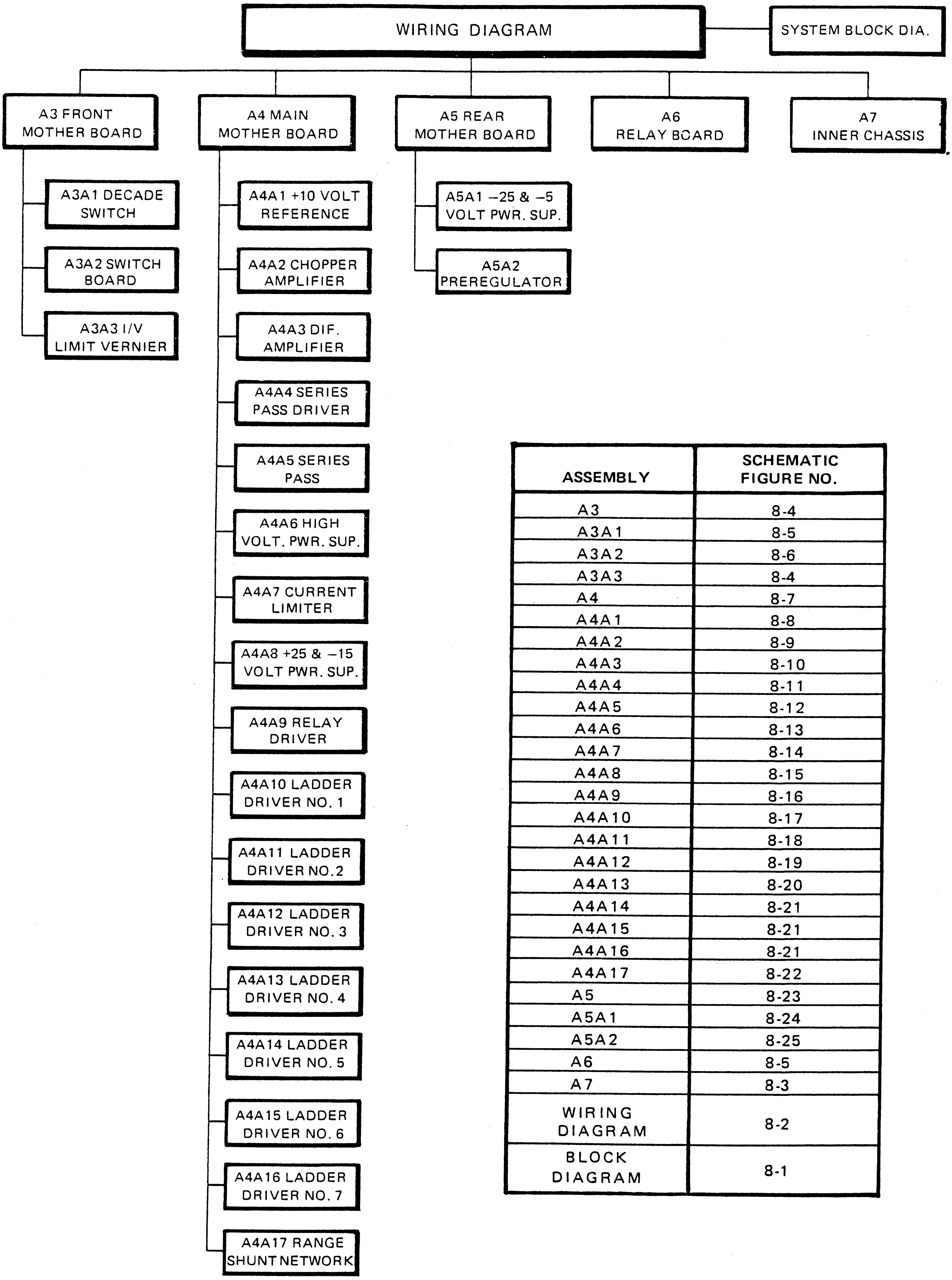
3-11. During the manufacturing processes, assembly identifiers have been assigned to the completed printed circuit boards. A printed circuit board may be identified by a 3000 series number that is silk-screened on the land pattern side of the assembly, or by a six-digit FLUKE part number located on the component side.

### 3-12. Schematic Diagram Identifiers

3-13. Figure 3-1 contains a chart which lists all of the diagrams associated with this instrument. These diagrams are located at the rear of the manual.

## 3-14. FUNDAMENTAL CIRCUIT DESCRIPTION.

3-15. The circuitry of the Model 3330B consists basically of a high-gain operational amplifier such as the one shown in Figure 3-2. A precision reference voltage fur-




| ASSEMBLY | SCHEMATIC FIGURE NO. |
|---|---|
| A3 | 8-4 |
| A3A1 | 8-5 |
| A3A2 | 8-6 |
| A3A3 | 8-4 |
| A4 | 8-7 |
| A4A1 | 8-8 |
| A4A2 | 8-9 |
| A4A3 | 8-10 |
| A4A4 | 8-11 |
| A4A5 | 8-12 |
| A4A6 | 8-13 |
| A4A7 | 8-14 |
| A4A8 | 8-15 |
| A4A9 | 8-16 |
| A4A10 | 8-17 |
| A4A11 | 8-18 |
| A4A12 | 8-19 |
| A4A13 | 8-20 |
| A4A14 | 8-21 |
| A4A15 | 8-21 |
| A4A16 | 8-21 |
| A4A17 | 8-22 |
| A5 | 8-23 |
| A5A1 | 8-24 |
| A5A2 | 8-25 |
| A6 | 8-5 |
| A7 | 8-3 |
| WIRING DIAGRAM | 8-2 |
| BLOCK DIAGRAM | 8-1 |

Figure 3-1. MODEL 3330B DIAGRAMS

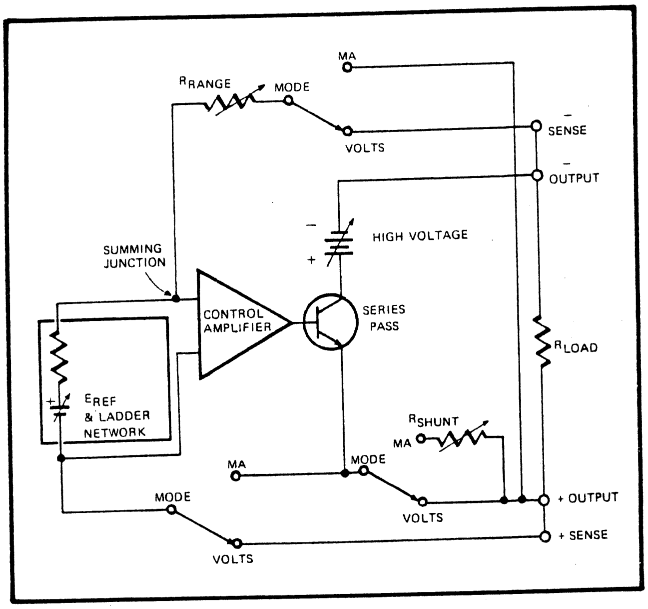



Figure 3-2. BASIC INSTRUMENT CIRCUITRY (DRAWN WITHOUT THE PREREGULATION LOOP)

nished by the reference supply and ladder network provides a current through the range resistor equal to the dialed output. The voltage developed across the range resistor furnishes a signal to the control amplifier that determines the rate of conduction of the series pass element. The conduction level of the series pass element then establishes the appropriate output voltage or current.

3-16. Two major loops actually form the instrument circuitry. One loop consists of an ac pre-regulator and the other is the main dc regulator. Each of these loops is described separately in the following paragraphs.

## 3-17. Voltage Mode

3-18. PRE-REGULATOR. This loop consists of the Pre-regulator and the Voltage Controlled Oscillator (VCO) shown in Figure 3-3. The VCO samples the voltage present across the series pass element and supplies pulsed timing information related to the load power requirement. These pulses are synchronized to the start of the line frequency cycle and are applied to the pre-regulator. The pre-regulator then initiates line current flow to the high voltage supply in only the amount necessary to meet the actual load requirement, thereby improving the efficiency of the instrument.

3-19. MAIN REGULATOR LOOP. The main regulator loop consists of a Reference Supply and Ladder Network, a Control Amplifier, the Series Pass Element, and a High Voltage Power Supply. The configuration is shown in Figure 3-3 and is redrawn in bridge form for explanation in the same illustration.

3-20. The reference supply/ladder network and $R_{SOURCE}$ form one side of the bridge, while the series pass element/high voltage supply and $R_{RANGE}$ form the other side. What the operator is doing when he dials an output voltage is to vary the Ladder Network which effectively produces a variable $E_{REFERENCE}$. The current from $E_{REFERENCE}$ is determined by the Ladder and the effective voltage of $E_{REF}$. This current passes through $R_{RANGE}$ developing a voltage across it which is equal to the dialed output voltage. When the voltage across $R_{SOURCE}$ equals $E_{REF}$, and the voltage across $E_{RANGE}$ equals $E_{OUT}$, a state of balance exists across the bridge, and there is zero potential across the inputs to the amplifier. When a new output voltage is dialed into the instrument, a state of imbalance will momentarily exist because $E_{OUT}$ will no longer be equal to the voltage across $R_{RANGE}$. If, for example, the instrument is operating at 100 volts and is subsequently dialed to 500 volts, a positive error voltage will appear at the summing junction and at the input to the amplifier. This amplified positive error voltage (the control amplifier is non-inverting) is applied to the series pass element causing it to conduct harder and resulting in a lower voltage drop across it. Through the action of the series pass and the pre-regulator (mentioned later), the output voltage will rise until it equals the voltage across $R_{RANGE}$, or until the bridge is again balanced. The gain of the control amplifier is very high and provides the bulk of the regulation.

3-21. At the same time the control amplifier is causing the series pass element to increase in conduction, or, in other words, producing a lower voltage drop across the series pass, the VCO is sampling $E_{SERIES\ PASS}$ and affecting the rest of the pre-regulator loop to increase the output of the high voltage supply.

## 3-22. Current Mode

3-23. PRE-REGULATOR LOOP. Operation of the pre-regulator loop is essentially the same in current mode as it is in voltage mode. The voltage across the series pass element is sampled by the VCO which causes the pre-regulator to supply power to the high voltage supply in the amount necessary to meet load requirements. A simplified block diagram of this mode is shown in Figure 3-4.

3-24. MAIN REGULATOR LOOP. The main regulator loop, like the pre-regulator loop, operates essentially the same in the current mode as in the voltage mode. The only difference is that the loop acts to maintain a constant vol-

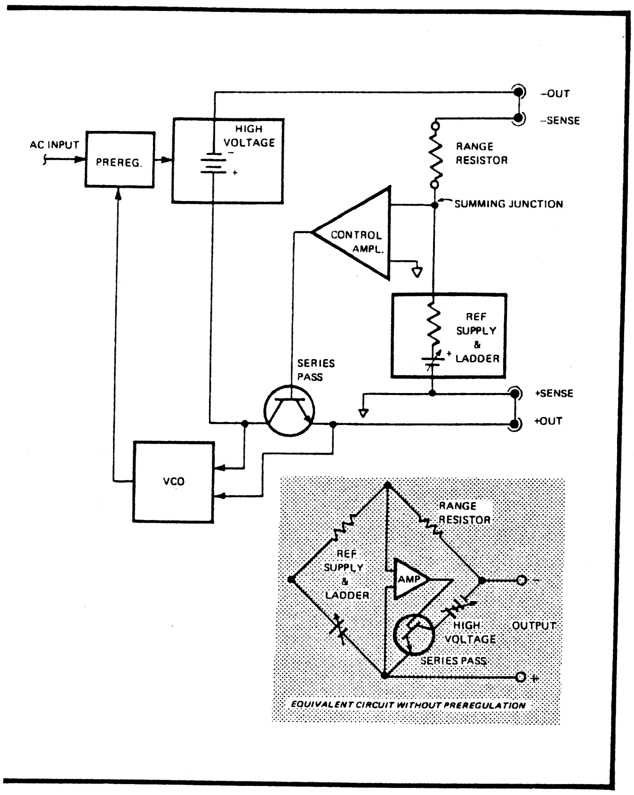



Figure 3-3. VOLTAGE MODE (SIMPLIFIED)

;e across the current shunt resistor (a precision resistor twork) to ensure that a constant current is available at : output terminals. The action of the series pass element 1 control amplifier maintains the output current at atever level is specified by the conditions of RRANGE 1 the reference supply/ladder network.

## 3-25. GENERAL CIRCUIT ANALYSIS

3-26. This description relates primarily to the system block diagram found at the rear of the manual, Figure 8-1, and discusses the interaction of the major circuits. Some of the circuits mentioned are not represented on the block diagram, but are included to maintain continuity in the discussion.

3-27. The basic reference voltage for the instrument is the 10 volt reference supply. The supply employs a selected reference amplifier to ensure that the output reference voltage is highly stable with respect to time and temperature. The reference supply output is applied to the input of a seven deck resistive ladder network. This ladder is controlled by the seven front panel decade switches in the local mode, and by a 28 line 8-4-2-1 binary coded decimal (BCD) input in the REMOTE mode. The resulting voltage at the summing junction is applied to the input of the control amplifier, which consists of the chopper amplifier and differential amplifier. The function of the control amplifier is to control conduction of the series pass so that the resulting voltage at the summing junction approaches zero. The chopper amplifies all frequencies from dc to approximately 30 Hz; the differential amplifier is used principally for frequencies from 30 Hz to approximately 200 kHz and has a dc path for signals coming from the chopper.

3-28. The current limiter, together with the control amplifier and series pass, forms a servo loop which limits instrument output current at a present value. The current

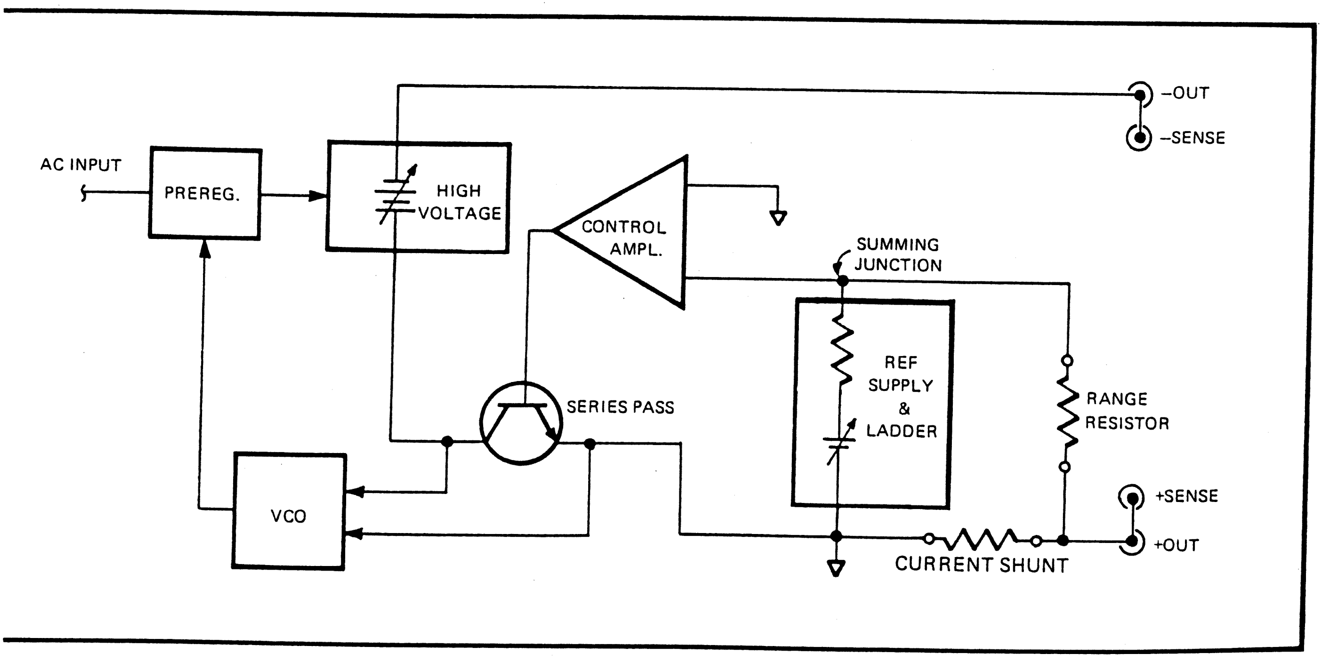



Figure 3-4. CONSTANT CURRENT MODE (SIMPLIFIED)

limiter continuously monitors output current and compares it to the setting of the CURRENT LIMIT control. When the voltage across the current sensing resistor exceeds the reference voltage set by the CURRENT LIMIT control, the limiter is activated. A portion of the current flowing from the reference supply into the summing junction is then bypassed, and the output current is limited or clamped to the preset value.

3-29. The series pass driver performs two functions: It amplifies control signals sufficiently to drive the series pass, and it disables the output in the event of an overvoltage or catastrophic over-current condition. When the voltage across the current sensing resistor exceeds a predetermined value, the trip circuitry acts to de-energize relays A5A2K1 and A5A2K2 which removes ac power from the high voltage transformer primary. The voltage trip circuit is activated whenever the output voltage exceeds the selected trip voltage set by the VOLTAGE TRIP VERNIER. Again A5A2K1 and A5A2K2 are de-energized and the instrument is tripped to standby. The instrument is reset by first pressing the STDBY/RESET switch to de-energize A4K5 and then the OPR switch.

3-30. The series pass regulates instrument output current in response to control signals from the series pass driver. The series pass is actually eight transistors connected in series, an arrangement which provides the regulated high voltage capability. The series pass assembly also contains a voltage controlled oscillator (VCO) which provides a pulsed timing signal to the pre-regulator. The pre-regulator increases the efficiency of the instrument by regulating the input to the high voltage power supply. It utilizes voltage level information from the VCO to provide full-wave phase control of the input line voltage of the high voltage transformer. Thus, the power supplied by the high voltage transformer is controlled to provide only that amount necessary for load requirements.

3-31. The high voltage power supply is connected as a full-wave bridge rectifier, obtaining its input from the pre-regulator and supplying dc voltages to the series pass regulators. Contained on the high voltage assembly is a rate limiter for the automatic crowbar which prevents excessive crowbar activation, thereby providing protection for the series pass transistors. See paragraphs 3-67, 3-70 and 3-74.

3-32. The function of the automatic crowbar circuitry is to quickly discharge the high voltage filter capacitors when down-ranging the instrument. This circuit also provides protection for the instrument during abnormal load conditions, such as short-circuited output. A second crowbar circuit, which is manually operated, is connected across the output terminals. It is used to limit compliance voltage while changing loads.

3-33. Operating voltages for the instrument are provided by the low voltage power supplies. The +25 volt and −15 volt supplies provide operating voltages for the +10 volt reference, chopper amplifier, and differential amplifier. A separate −25 volt dc supply furnishes operating voltages for all decade control relays. Operating voltages for the series pass driver are provided by a ±35 volt supply located on the current limiter assembly. A −5 volt supply provides the program supply voltage.

3-34. The 50 program input/output (I/0) lines provide remote control of all front panel control functions and remote indication of instrument power condition and voltage trip/current limit operation. Mode, standby/operate, polarity, manual crowbar, and voltage/current range input lines terminate in a relay driver, which supplies the driving current for the selected relay. Output voltage level is controlled by a 28-line 8-4-2-1 BCD input. The front panel controls are connected in parallel with the program I/0 lines, and the same circuits are activated in either remote or local operation. The selection of remote or local operation is made only at the front panel. When the OPR switch is pressed, front panel controls are enabled; when the REMOTE switch is pressed, instrument control is switched to the programmed input at J8.

3-35. Mode input commands are applied through the relay driver to relays A4K3 and A4K6. These relays change the instrument circuitry to provide either voltage or constant current operation. Together with the range relays A4K1 and A4K2, they select the appropriate voltage range resistor, current shunt, and chopper amplifier zero adjust control.

3-36. The standby/operate input is applied through the relay driver to relay A4K5. This relay controls the operation of relay A5A2K2, which in turn, controls relay A5A2K1. When operated, A5A2K1 connects main power to the pre-regulator. The remote polarity input is applied through the relay driver to relay A4K4. Upon command, A4K4 reverses the output voltage polarity at the front and rear terminals. The manual crowbar input operates relay A6K2. When activated, this relay shorts the output terminals through a 5 ohm resistor.

3-37. The 28-line output level input is applied to the seven-deck resistive ladder network and a set of relay switches, which are used to connect the reference voltage to the proper terminal of the network as a function of each digital input bit.

3-38. The 5-line current limit input consists of a 4-bit BCD input which is applied to the remote current limit circuit, and a single local/remote line which is applied through a relay driver to A3K1 and A3K6. Upon remote command, A3K1 closes and selects the current limit ladder. The circuit then performs the current limit adjustment in accordance with the BCD input. The voltage limit circuitry is arranged in the same way. The local/remote input operates relay A3K6 which selects the remote voltage limit ladder. Again, the BCD input controls the decoder which accomplishes the adjustment function.

## 3-39. CIRCUIT DESCRIPTIONS

3-40. The following paragraphs describe in detail the operation of each circuit. The information is grouped according to individual assemblies found in the Model 3330B. To find the description of a particular circuit, first determine the name of the assembly that the circuit is located on and proceed from there. For example, the VCO circuit is located on the Series Pass assembly A4A5.

### 3-41. Main Mother Board (A4)

3-42. Functioning as the parent assembly for assemblies A4A1 through A4A17, the Main Mother Board interconnects all the assemblies found on it and distributes signal paths to appropriate sections of the instrument. Individual circuit descriptions for A4A1 through A4A17 are provided in the following paragraphs.

3-43. Components mounted on the A4 board consist primarily of diodes and relays. Diodes CR1 through CR28 are associated with the ladder assemblies. Relays K3 and K6 form part of the mode selection circuitry. K2 is energized when the instrument is in the 1000 volt range. K1 is energized in the 100 volt range and de-energized in the 10 volt range. Relay K5 is the Standby/Operate relay, and K4 is the Polarity relay.

### 3-44. +10 Volt Reference Supply (A4A1)

3-45. The +10 Volt Reference Supply produces an extremely stable reference voltage upon which the instrument's stability is based. Range zero adjustments and a resistor for the current mode are also located in this assembly.

3-46. 10 VOLT REFERENCE SUPPLY. This is a voltage regulated power supply consisting of a stable reference amplifier, a differential comparator amplifier, and a series regulator. Reference amplifier IC2 contains a matched zener reference and amplifier elements to produce an extremely stable voltage with respect to time and termperature. Voltage variations at the regulator sense line (terminal 14) are developed across the voltage divider R10 through R13 and R2 and are applied to the other input of IC2. Any difference between the sense terminal voltage and the reference voltage is amplified by IC2 and IC1 and used to control the conduction of the series regulator Q1 and Q2, which establishes a +10 volt dc reference voltage at terminal 15. Variable resistor R10 provides adjustment of the regulated output voltage.

3-47. RANGE ZERO AND CURRENT SHUNT. The voltage divider of R16 through R21 allow zero adjustments in the voltage mode of operation. Resistor R22 is used in the current mode of operation.

### 3-48. Chopper Amplifier (A4A2)

3-49. The Chopper Amplifier compares low frequency and dc control signals from the Ladder summing junction to the +SENSE terminal voltage and amplifies any difference. The Chopper Amplifier circuitry consists of an input filter, a MOSFET chopper, an operational amplifier, a synchronous demodulator, an output filter, and a multivibrator.

3-50. Low frequency and dc control signals at terminal 6 are passed through the input filter C2, R1, and C3 to reject frequencies above 30 Hz. The MOSFET chopper Q1 modulates the signal appearing at the junction of its drain and R2. C4 couples the resultant to the gate of JFET Q2. The output signal at the drain of Q2 is then amplified by the operational amplifier IC1, which has a gain of approximately 420. The paraphase amplifier Q3 amplifies the output of IC1 and provides two equal amplitude, but 180° out-of-phase signals. The collector signal of Q3 is coupled by C16 to the shunt demodulator Q4. The resulting demodulated signal appearing at the junction of C17 and R24 is filtered by R24, R26 and C18, leaving only the amplified dc and low frequency signals. The emitter signal of Q3 is applied through C14, R21, C15, R25, R23, and C22 to C18, where it is used to cancel any chopper ripple at 215 Hz.

3-51. The 215 Hz multivibrator is formed by Q6, Q7 and associated timing networks, in addition to a driver Q5. Variable resistor R43 adjusts the level of the signal applied to the driver Q5, and subsequently the output signal applied to the gate of Q1. The collector signal of Q5 is applied to the drain of Q1 to compensate for spikes coupled between the gate and drain. Variable resistor R34 provides adjustment of the compensation signal. An output signal at the collector of Q7 is applied to the base of Q4, which synchronously demodulates the Chopper Amplifier output.

### 3-52. Differential Amplifier (A4A3)

3-53. The Differential Amplifier provides a control signal to the Series Pass Driver. Part of the current limit circuitry is also located in this assembly. The differential amplifier consists of Q2 through Q11, and the current limit circuitry consists of Q1, Q12, CR10 through CR12, and R7 through R10. A restraining circuit of Q13, and Q14, and associated circuitry, prevents the chopper Amplifier from saturating in the standby mode.

3-54. DIFFERENTIAL AMPLIFIER. Input control signals from the A4A10 through A4A16 Ladder summing junction are applied to terminal 5 for amplification by the differential amplifier of Q2 through Q10. High frequency input signals are coupled through C1 to one input of the differential amplifier. Low frequency and dc control signals are applied through R21 to terminal 6, where they are amplified by the A4A2 Chopper Amplifier. Over-voltage protection for the differential amplifier and Chopper Amplifier inputs is provided by CR2 through CR9 and associated components. The amplified control signals from the Chopper Amplifier are applied to terminal 3 as the other input of the differential amplifier. The resulting output at the collector of Q9 is applied to the emitter follower Q11, which provides a low impedance drive signal required by the A4A4 Series Pass Driver at terminal 1. Transistor Q8 is a current source for one stage of the amplifier and provides common mode rejection at the input to the amplifier.

3-55. CURRENT LIMIT CIRCUITRY. The current limit circuitry consisting of Q1, Q12, CR10 through CR12, and R7 through R10 provide a means of bypassing Ladder current during a current limit condition. Transistor Q1 receives base and emitter operating voltages from the A4A7 Current Limiter and is normally cut-off. However, if the output current of the instrument exceeds a preset value established by the CURRENT LIMIT control, Q1 is driven into conduction by a corresponding drop in emitter voltage and turns on transistor diode Q12. Conduction of these transistors shunts the Ladder current through the range resistor R9, thus limiting the control signal applied to the A4A4 Series Pass Driver and the output current of the instrument.

3-56. RESTRAINING CIRCUIT. The circuitry of Q13 and Q14 ensures that the Differential Amplifier is provided with a dynamic load during a standby condition to keep the output of the amplifier relatively constant. This also maintains fast response during turn-on and range changes. The emitter voltage of Q14 is derived from the emitter of Q11, while the base voltage of Q14 is derived from the voltage divider of R33 and R34. The collector of Q14, whose conduction depends primarily on its emitter voltage, supplies base drive to Q13. The output of Q13 drives diode-connected Q12, controlling the current appearing in the summing junction. In this manner, the loop is completed and the output of the Differential amplifier will remain nearly constant, thus preventing the Chopper from going into saturation.

### 3-57. Series Pass Driver (A4A4)

3-58. The Series Pass Driver applies amplified control signals to the A4A5 Series Pass assembly. Additional circuits found on the assembly are the overcurrent/voltage trip circuit and the front panel meter multiplier resistors. A three-stage amplifier composed of Q5 through Q7 forms the series pass driver. The overcurrent/voltage trip circuitry consists of Q1 through Q4 and Q8. The meter multipliers are R1 through R6.

3-59. SERIES PASS DRIVER. The series pass driver of Q5 through Q7 amplifies the input regulation control signal at terminal 1 sufficiently to drive the A4A5 series-pass transistor Q8. The common-base configuration of Q7 provides isolation of the input circuitry and the required voltage gain of the control signal. The common-collector stages of Q5 and Q6 provide sufficient current gain of the drive signal applied out terminal 4.

3-60. OVERCURRENT/VOLTAGE TRIP. The overcurrent/voltage trip circuitry, through relay A5A2K2, removes ac power from the high voltage transformer whenever a catastrophic overcurrent or voltage trip occurs. Transistor Q3 is a current source for the solenoids of this relay and produces a −30 volt dc operating voltage at terminal 10. Transistors Q1 and Q2 activate the voltage trip feature. Transistors Q4 and Q2 activate the overcurrent trip feature. Resistors R22 and R29 are the sensing resistor for the overcurrent trip feature. Transistor Q8 is the driver amplifier for the OPR indicator lamp.

3-61. The voltage trip feature is activated when the output of the instrument exceeds the level established by the VOLTAGE TRIP controls, or when triggered by the rate limiter. (Paragraph 3-74). Transistor Q1 receives base voltage from the wiper of the VOLTAGE TRIP RNIER control or Ladder. When the base voltage, ich is proportional to the output voltage of the instru- nt, exceeds the established level at the base of Q1, transistor conducts and biases Q2 into saturation. e conduction of Q2 clamps the voltage at terminal to nearly zero volts and de-energizes the associated ays. This action trips the instrument to the STANDBY de. Transistor Q8 is also turned off by a corresponding crease in negative base voltage, and the OPR lamp is tinguished. The instrument is returned to the OPR de by first selecting the STDBY/RESET mode, which rns off Q2 by applying a circuit common to terminal through the contacts of A4K5, and then selecting the R mode.

62. The overcurrent trip feature is a protective circuit at functions in the event of a current limit malfunction. hen the current through the sensing resistors of R22 d R29 exceeds 200 milliamperes, Q4 conducts and biases 2 into saturation, which activates the trip circuit discussed the preceding paragraph.

63. METER MULTIPLIERS. Resistors R1 through 6 provide a current through the front panel meter that is roportional to either the output voltage or current of the nstrument. When the METER READING VOLTAGE witch is pressed, R3 through R6 and A4R1 through R3 re connected to the meter and produce a reading propor- ional to the output voltage of the instrument. Variable esistor R5 allows calibration of the voltage reading. When the METER READING CURRENT switch is pressed, R1 and R2 are connected to the meter and produce a eading proportional to the output current of the instru- nent. Variable resistor R2 allows calibration of the current eading.

## 3-64. Series Pass (A4A5)

3-65. The Series Pass contains the series-pass transistors used to control the output current or voltage from the instrument. Additional circuitry consists of the pre-regu- lator VCO used to control the amount of voltage across the series pass transistors, and an automatic "crowbar" driver used to limit the maximum voltage across the series-pass elements. A +150 volt power supply is also in- cluded to provide operating voltages for the series-pass and VCO circuitry. The +150 volt power supply consists of the bridge rectifier CR1 through CR4, and the series pass elements are Q1 through Q8. The VCO consists of the relaxation oscillator Q9 and the associated timing networks. Transistor Q10 is the automatic "crowbar" driver.

3-66. +150 VOLT POWER SUPPLY. AC voltage at terminals 8 and 9 is rectified by diodes CR1 through CR4 to produce an unfiltered positive voltage. This voltage is isolated by CR5 and filtered by C2 to provide a +150 volt dc operating voltage for the series pass transistors. The voltage divider of R1 through R3 and zener diode CR6 produces a clipped full-wave rectified six volt synchron- izing signal for the VCO, Q9.

3-67. SERIES PASS TRANSISTORS AND AUTOMATIC CROWBAR. The series-pass transistor of Q1 through Q7 are normally saturated, and transistor Q8 is absorbing the total voltage required to establish the output of the instru- ment. However, when the output level or load is changed and the voltage across Q8 exceeds 150 volts, Q1 through Q7 absorb the additional voltage. The pre-regulator circuitry then reduces the output of the high voltage supply and the voltage across the series pass transistors. As soon as the voltage drop across Q8 decreases below 150 volts, Q1 through Q7 again saturate, and Q8 absorbs the total regu- lation voltage. Load or output changes that increase the voltage across the series pass transistors to above 225 volts result in the conduction of the "crowbar" driver, Q10. Conduction of Q10 energizes relay K1 in the A4A6 High Voltage assembly, which places a load across the high vol- tage rectifier. This action limits the voltage across the series pass transistors and provides a quick discharge path for the high voltage filter capacitors.

3-68. PREREGULATOR VCO. Unijunction transistor Q9 and associated timing elements comprise a voltage- controlled oscillator which furnishes a turn-off pulse to the pre-regulator. A clipped, six volt pulse, synchronous with the 60 Hz line, is applied to base 2 of Q9 (see Figure 3-5). The potential at the emitter of Q9 depends upon the charge on capacitors C4 and C5. The charge on C5 depends upon the voltage across the series pass control transistor Q8. When the charge on C4 and C5 equals a critical level, determined by the bias on Q9, Q9 will conduct, delivering a pulse of current through transformer T1 to the pre-regulator. The oscillator will be enabled only during interval $t_1$ and the point at which oscilla- tion will occur is determined by the charge on C5. If the Charge across C5 increases, the initial output pulse of the oscillator will occur earlier in each half cycle. During each half cycle, the initial pulse from the oscilla- tor will switch the pre-regulator off to control the amount of line power supplied to the high voltage transformer. Thus, if the voltage across Q8 increases, the pre-regulator is switched off earlier in each half cycle. This, in turn, reduces the voltage across Q8 to the proper working value.

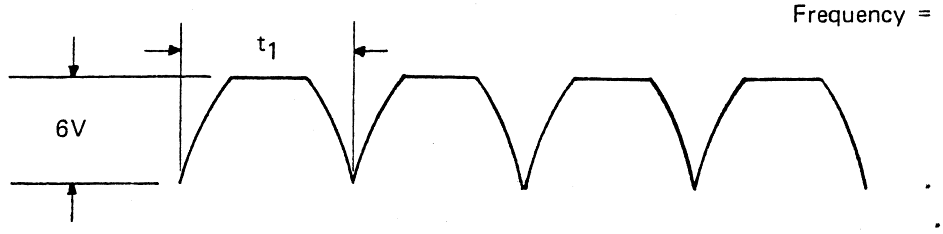



Figure 3-5. VCO OPERATING VOLTAGE

### 3-69. High Voltage Power Supply (A4A6)

3-70. The High Voltage Power Supply produces the required voltage necessary to obtain the pre-selected output. Additional circuitry consisting of a sink supply and a portion of the automatic "crowbar" circuitry is also included and allows rapid downranging of the instrument. The automatic "crowbar" circuit also prevents damaging of the series pass elements if the output terminals are shorted or an overload occurs. The high voltage power supply consists of the bridge rectifier CR1 through CR4. The sink supply is composed of the voltage doubler CR5 through CR8, and the automatic "crowbar" circuit consists of K1 and R7 with the rate limiter of Q1 thru Q4 acting to limit the number of times the crowbar may be activated at a given time.

3-71. HIGH VOLTAGE POWER SUPPLY. AC input voltage from the pre-regulator at terminals 15 and 16 is rectified by CR1 through CR4 to provide high level operating voltage for the instrument. Resistors A4R6 through A4R8 and capacitors A4C5 through C7 filter the resulting output appearing on terminal 5.

3-72. SINK SUPPLY. AC input voltage at terminals 1 and 2 is rectified and filtered by CR5 through CR8, C1, C2, R4, and R5. The resulting −700 volts output at terminal 12 is applied to the A4A5 Series Pass assembly and ensures a minimum current through the series-pass element when the instrument is downranged.

3-73. AUTOMATIC CROWBAR. Relay K1 and the resistor R7 are part of the automatic "crowbar" circuit used to provide a quick discharge path of the filter capacitors contained within the instrument. When an overvoltage condition across the series pass elements is detected, A4A5Q10 will conduct and energize K1. The contacts of K1 place R7 in parallel with the high voltage power supply which provides a discharge path for the filter capacitors.

3-74. RATE LIMITER. The rate limiter, in conjunction with the automatic crowbar, protects the series pass transistors. If the automatic crowbar activates more often than the times given in Figure 1-1 of Section I, the rate limiter relay K2 will supply −35 v to the voltage trip circuitry, placing the instrument in the voltage trip mode. Q1 thru Q4, CR12 thru CR19, R3, R9 thru R14, C4 thru C6, and K2 comprise the rate limiter circuitry. When the crowbar activates due to excessive voltage across the series pass, a voltage develops across R3 charging C5 directly and charging C4 through R9. If there is excessive crowbar action, C4 will charge sufficiently to turn on Q1 and Q2, energizing K2. If the crowbar rate is not excessive, the charge on C4 will not become great enough to turn on Q1 and Q2. Meanwhile, as a result of the crowbar action, C5 becomes charged; when the charge is high enough, Q4 conducts, turning off Q3. Some time later, it will discharge, turning off Q4 and allowing Q3 to conduct. When Q3 turns on, it discharges C4, and the rate limiter is reset. However, the 3330B must be manually reset.

### 3-75. Current Limiter (A4A7)

3-76. The Current Limiter contains two separate plus and minus 35 volt dc power supplies and part of the current limit circuitry. The ±35 volt power supply is a bridge supply with rectifiers CR1 through CR4 and the regulators Q1 and Q2. The current limit circuitry consists of a three-stage amplifier, Q3 through Q5, and the I LIMIT/V TRIP drivers Q6 and Q7.

3-77. ±35 VOLT DC POWER SUPPLIES. The ac input voltage applied to terminals 7 and 9 is rectified and filtered by CR1 through CR4, R1, C1, R4, and C4. Positive unregulated voltage is applied to Q1, and negative unregulated voltage is applied to Q2. Zener diodes CR5 and CR7 establish a reference voltage at the base of Q1 and Q2. The conduction of Q1 and Q2 produces ±35 volt dc output voltages available at terminals 1 and 3. A −3.9 volt dc output at terminal 15 is developed by CR6 and R6 for use as a bias voltage in the A4A3 Differential Amplifier.

The unregulated negative output is also applied through R8 and R26 to terminal 6 for use in the A3 assembly indicator lamps.

3-78. CURRENT LIMIT CIRCUITRY. The current limit circuitry receives a dc control voltage at terminal 10 which is proportional to the output current of the instrument. Diode CR12 applies this signal to the base of Q5. The emitter of Q5 is connected through R21 to terminal 11, which receives a control voltage from the wiper of the CURRENT LIMIT VERNIER control or Ladder. Variable resistors R23 and R24 are also part of this circuit and allow calibration of the CURRENT LIMIT LO and HI settings. When the output current of the instrument attempts to exceed the value preset with the CURRENT LIMIT control, Q5 is driven into conduction by the increase in voltage at terminal 10, which drives Q4 and Q3 into conduction. This action bypasses a portion of the Ladder current through the A4A3 Differential Amplifier range resistor connected to terminal 16, and thereby limits the output current of the instrument. The regenerative pair of Q6 and Q7 are also driven into conduction at this time and supply a drive current to the A3 I Limit/V Trip lamp which is also illuminated on the STDBY/RESET or VOLTAGE TRIP mode by a zero volt control signal at terminal 5. This input also brings Q3, Q4, Q6 and Q7 into conduction.

## 3-79. +25 and −15 Volt Power Supply (A4A8)

3-80. The +25 and −15 Volt Power Supply consists of two separate low-ripple power supplies used to produce operating voltages for the instrument. The +25 volt power supply is composed of a bridge rectifier CR1 through CR4 and the regulator Q2 through Q6. The −15 volt power supply consists of a bridge rectifier CR7 through CR10 and the regulator Q7 through Q9. Transistor Q1 and associated components are not used in this instrument.

3-81. +25 VOLT POWER SUPPLY. AC voltage at terminals 13 and 14 is rectified and filtered by CR1 through CR4, C2, R4, and C3. Transistor Q2 is a constant current source for the regulator consisting of Q3 through Q6. The differential comparator amplifier of Q5 and Q6 ... a reference voltage at the base of Q6 derived from ...iode CR6. Variations at the +25 volt output ...l 10) are developed across the voltage divider through R10 and are applied to the base of Q5. ...fference between the base voltages of Q5 and Q6 ...ified and used to control the conduction of the ...ass driver Q3. Conduction of Q3 controls the ...tion of the series-pass regulator transistor Q4, which ...shes a low-ripple +25 volt dc output at terminal ...ariable resistor R9 allows adjustment of the regulator ...

3-82. −15 VOLT POWER SUPPLY. AC voltage at terminals 1 and 6 is rectified and filtered by CR7 through CR10, R14, and C8 to produce a negative operating voltage for the regulator of Q7 through Q9. A voltage divider comprised of R18 and R19 references the base of Q9 to a potential dependent on the +25 and −15 volt output. Variations in the output are amplified by Q9 and used to control the conduction of Q8. The conduction of Q8 controls the series-pass regulator Q7, which establishes a low-ripple −15 volt dc output at terminals 3 and 9.

## 3-83. Relay Driver (A4A9)

3-84. The Relay Driver activates the various relays within the instrument on commands from the A3 assembly. The relay drivers Q1, Q3, Q5, and Q7 are identical PNP switches used to activate relays. Transistors Q4, Q10, Q11 and Q12 are used to invoke the STDBY/RESET mode whenever a mode or polarity change occurs. A Logic "1" (0 to +0.5 volts) will turn the relay drivers on, and a Logic "0" (+4.5 to +20 volts) will turn them off.

3-84. RELAY DRIVERS. Relay drivers Q1, Q3, Q5, and Q7 are identical PNP switches. Each transistor receives −25 volts at its collector derived from the associated relay. Base voltage is dependent on the input logic signal from the A3 assembly. Zener diodes located in the collector circuit protect the transistors from the induced voltages developed by the relay solenoids. The drivers consisting of Q2, Q8 and Q6, Q9 provide current for relay operation. Circuitry for these drivers is essentially the same as the other drivers, with the exception of the additional base circuitry used to invoke the STDBY/RESET mode.

3-86. STDBY/RESET MODE. When changing a program between the voltage or current mode, it is necessary to temporarily place the instrument in standby to prevent uncontrolled voltages from appearing on the output terminals. This is accomplished by circuitry located on the relay driver assembly. When the negative or low input is applied to the base of Q9 (current mode command), it is also applied to a differentiator consisting of C6 and R30. The negative differentiator output is coupled through diode CR12 to the base of Q11, turning it on. Q12 turns on at the time that Q11 does, and stays on until C7 discharges through R26 to a value below 0.6 volts, a period of approximately 100 milliseconds. In the interval that Q12 is on, the base of Q3 is effectively connected to ground, which de-energizes relay A4K5 and places the instrument in standby. When the positive or high input is applied to the base of Q9 (voltage mode command), it is also applied to the base of Q4. The signal is inverted in Q4, differentiated by C5 and R28, and applied to Q11.

Again, Q11 and Q12 together with Q3 act to place the instrument in standby for 100 milliseconds. The momentary standby function is also invoked by application of a polarity change command. A separate inverter Q10 together with associated differentiator circuits provide the negative trigger to Q11.

### 3-87. Ladders (A4A10 through A4A16)

3-88. There are seven Ladders contained in the instrument. Each Ladder consists essentially of the same circuitry with the only difference being the tolerance of the divider components. The Ladder circuitry consists of relay driver/decoders and a ladder network.

3-89. RELAY DRIVER/DECODERS. Relay Drivers Q1 through Q4 are PNP switches. A Logic "1" (0 to +0.5 volts) will turn the drivers on, and Logic "0" (+4.5 to 20 volts) will turn them off. Each transistor receives a –25 volt dc collector voltage through the associated relay of K1 through K4. Base bias voltage is dependent upon the input logic signal from the A3 assembly. Diodes CR5 and CR6 convert the 8-4-2-1 coded inputs to a 4-4-2-1 code. This conversion is necessary to limit the maximum digital command to a four digital word of eleven which corresponds to the maximum decade range.

3-90. LADDER. Each deck of the seven ladder decks performs an identical function. The relative position of the decks, with respect to the summing junction, determines the significance of that deck's contribution to the ladder output. For example, Ladder no. 1, which is nearest the junction, determines the most significant portion of the output, and Ladder no. 7, which is farthest from the junction, determines the least significant portion. Although the circuit arrangement of each ladder is the same, the individual assemblies are not interchangeable, because component tolerance are different.

3-91. Ladder network R1 through R10, reed relay switches K1 through K4, and switch drivers Q1 through Q4 comprise a four-bit, weighted-resistor, digital-to-analog decoder. The analog output of the decoder is weighted in terms of elevenths of the reference voltage (+10 volts) so that it can be programmed by input digital words 1 through 11. The ladder network functions as a voltage divider, where resistors R3 through R10 are, in various combinations, connected in series with R1 and R2, which are the output resistors. Assume, for example, the four-bit digital word 0101, representing 5, is present at the decoder input. The first and third bits, present at pins 16 and 14 respectively, turn on drivers Q2 and Q4 and, through them, relays K2 and K4, while the second and fourth bits, present at pins 15 and 13, bias drivers Q3 and Q1 off. With K2 and K4 energized, +10 volts is applied to R5 and R9. The parallel combination of R5, R6 and R9, R10 in series with R1, R2 provide an output that is five-elevenths of the available decoder output. This decoder deck together with the other decoder decks produces a combined output which corresponds to the 28-word BCD input. An important characteristic of the ladder is that its output impedance is constant regardless of the reed switch positions, thereby presenting a constant load to the reference supply.

3-92. Referring to the simplified diagram of Figure 3-6, the operation of the Ladders can be more easily seen. The numerals "4", "4", "2", and "1" refer to the BCD commands, and the 1R, 2R, etc., refer to the relative weights of the associated Ladder segments. The value of 1R is 25K, so that 2R is 50K, etc. Selecting various combinations of "R" in each Ladder varies the current supplied to the Range resistors; this current is available in increments of 1/11 from each Ladder.

### 3-93. Range/Shunt Networks (A4A17)

3-94. The Range/Shunt Networks allow calibration of the various voltage/current ranges of the instrument. Variable resistors R21, R18, and R15 are used to calibrate the full-scale output on the corresponding 10, 100, and 1000 volt ranges. Variable resistors R1, R5, and R9 are used to calibrate the full-scale output on the corresponding 1, 10, and 100 milliampere ranges.

### 3-95. Rear Mother Board (A5).

3-96. The Rear Mother Board contains the A5A1 power supply assembly and the A5A2 Pre-regulator Assembly. Also located on the board are K1, the CURRENT LIMIT/VOLTAGE TRIP FLAG delay; K2, used in current limit and voltage trip conditions; and K3, the CURRENT LIMIT/VOLTAGE TRIP FLAG. A5T1 on this assembly couples the VCO pulses from the A4A5 Series Pass Assembly to the A5A2 Pre-regulator assembly.

### 3-97. –25 and –5 Volt Power Supply (A5A1)

3-98. The –25 and –5 Volt Power Supply consists of two separate low-ripple power supplies that produce the logic power and relay operating voltages for the instrument. The –25 volt power supply consists of a bridge rectifier CR1 through CR4, positive rectifier CR5 and CR6, the regulator Q1 through Q3, and the turn-on delay circuit Q4. The –5 volt power supply consists of a bridge rectifier CR7 through CR10 and the regulator Q5 through Q8.

·99. –25 VOLT POWER SUPPLY. AC voltage at ɜrminals 1 and 2 is rectified and filtered by CR1 through R4 and C1 to provide a negative operating voltage for ıe regulator Q1 through Q3. Diodes CR5 and CR6 pro-uce a positive operating voltage for the regulator. The ɔmparator amplifier Q1 receives a reference voltage at s emitter derived from zener diode CR12. Variations t the –25 volt output (terminal 6) are developed across ıe voltage divider of R4 through R6 and applied to the ase of Q1. Any difference between the base and emitter ɔltage of Q1 is amplified and used to control the con-uction of the series pass regulator Q2. Conductions of ⟩2 controls the conduction of the series-pass transistor ⟩3, which establishes a low-ripple –25 volts dc output. 'ariable resistor R5 allows adjustment of the regulator utput. The turn-on delay circuit consisting of C4, R7, 'R13, Q4 and K1 prevents the –25 volt output from ppearing at terminal 6 for approximately three seconds fter initial turn-on.

-100. –5 VOLT POWER SUPPLY. AC voltage at ɜrminals 14 and 15 is rectified and filtered by CR7 through 'R10 and C5 to produce a negative operating voltage for ıe regulator configuration of Q5 through Q8. Additional egative operating voltage is obtained from the –25 volt ower supply through R8 and R10. The comparator ampli-er Q7 receives a reference voltage at its emitter derived :om zener diode CR11. Variations at the –5 volt output terminal 16) are developed across the voltage divider of :11 and R12 and applied through R14 to the base of Q7. ɩny difference between the base and emitter reference oltage of Q7 is amplified and used to control the conduc-ion of the series-pass regulator Q6. Transistor Q8 func-ions as a current limiter to prevent the output current :om exceeding 300 ma. The conduction of Q6 controls ıe conduction of the series-pass transistor Q5, which stablishes a low-ripple –5 volt dc output at terminal 6. Variable resistor R11 allows adjustment of the ɘgulator output.

## ⟩-101. Pre-regulator (A5A2)

ɨ-102. The Pre-regulator controls the ac power dissipated n the instrument by passing only enough power to the ɩigh voltage circuitry to meet the output load requirement. 'he Pre-regulator consists of the ±V power supply CR1 hrough CR4, a relay power supply CR6 through CR9, ɪre-regulator drivers Q2 and Q4 through Q7, a pre-regulator ɪridge CR10 through CR13 and Q1, and current limiter Q3.

-103. ±V POWER SUPPLY. AC voltage at terminals 11 nd 12 is rectified by CR1 through CR4 to provide un-ɪltered ±V operating voltages. Diode CR5 provides iso-ɪtion of a +10 volt filtered output.

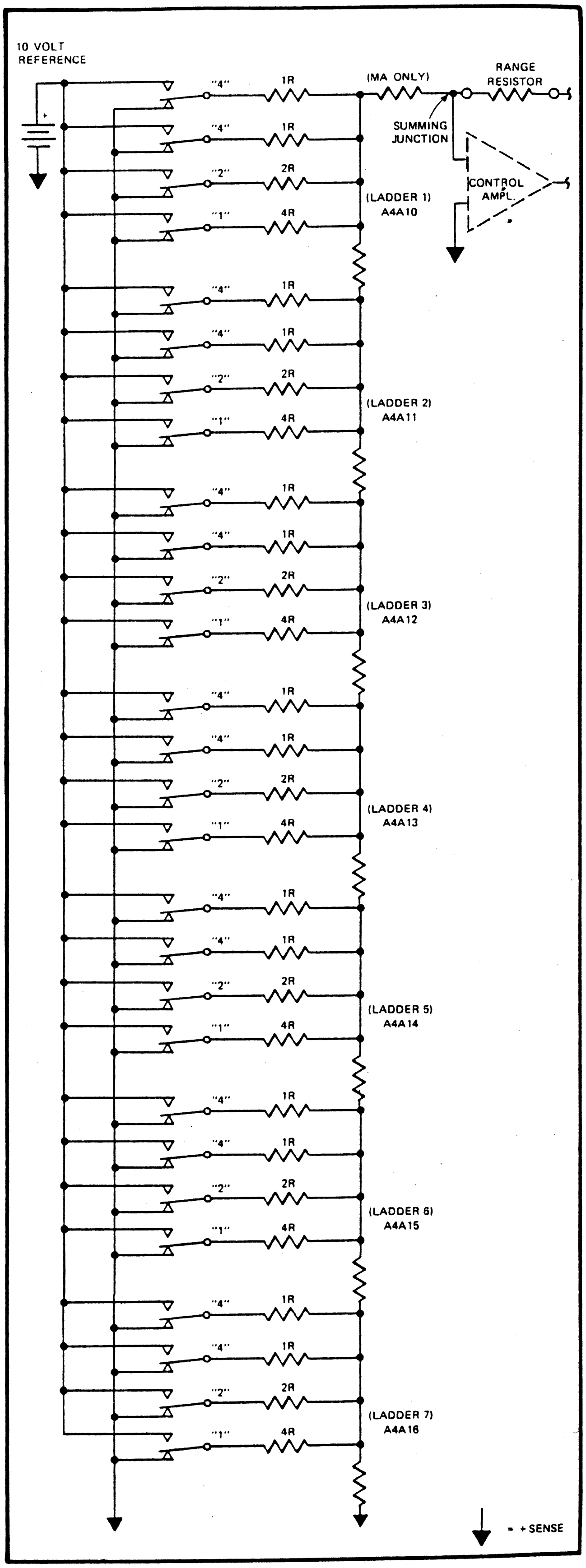



Figure 3-6. LADDER NETWORK – SIMPLIFIED VERSION

3-104. RELAY OPERATION. Operating voltage for relay K1, which applies ac voltage to the pre-regulator bridge, is produced by the bridge rectifier CR6 through CR9. Relay K2 is energized when the instrument is in operate. During an overcurrent or voltage trip condition, both relays de-energize and remove the ac input to the pre-regulator.

3-105. PRE-REGULATOR DRIVERS. The series of VCO pulses are coupled across A5T1 from the series pass assembly to the input of the pre-regulator. At the beginning of each 60 Hz half cycle, Q5 is turned on by the positive going +V voltage through R17 and L2. Conduction of Q5 saturates Q4, Q2, and Q1. Conduction of Q1 allows current to flow in the primary of the high voltage transformer. Sometime during each half cycle, the initial pulse from the VCO will trigger the regenerative pair (Q6 and Q7) into saturation. With Q6 and Q7 conducting, transistors Q5, Q4, and Q1 turn off and remain off as long as Q6 and Q7 are conducting. Transistors Q6 and Q7 remain conducting until the end of each half cycle. At this time, the current through them automatically drops below the regenerative value, due to the zero-crossing of the full-wave rectified 60 Hz sine wave voltage (−V) at the emitter of Q7. Therefore, transistor Q1 is held off for the remainder of the half cycle, which corresponds to the period that the VCO is generating pulses. This limits the amount of power to the high voltage transformer and reduces the power dissipation requirements for the series pass transistors.

3-106. PRE-REGULATOR BRIDGE. The pre-regulator bridge of CR10 through CR13 and Q1 passes or attenuates the ac voltage applied to the high voltage transformer T1 in amounts determined by the Pre-regulator drivers. The bridge connected diodes of CR10 through CR13 provide an unidirectional current flow through the control element Q1. Positive alternations are passed by CR10 and CR13. Negative alternations are passed by CR11 and CR12. Whenever Q1 is turned-off, R5 and C6 provide a dynamic load for the bridge. Over-voltage protection for Q1 is provided by zener diode CR14. Overcurrent protection for Q1 is provided by R2 and the current limiter Q3. Essentially the bridge functions as a switch in the ac line. Refer to the simplified diagram and the stylized waveforms of Figure 3-7. The portion of the ac line waveform that passes to the High Voltage transformer is represented by the shaded portion of waveform 1. Waveform 2 represents the base drive to the bridge transistor. The pulses of waveform 3 are from the VCO. Note that the initial pulse turns off the base drive to the bridge transistor, and that the next zero crossing of the line waveform turns the base drive back on, resulting in current flow through the bridge. Only the first VCO pulse is used for turn-off.

3-107. CURRENT LIMITER. Maximum current through Q1 is limited to 17 amperes by the current limiter Q3. Normally, Q3 is cut-off; however, if the current through R2 in the pre-regulator bridge exceeds 17 amperes, Q3 conducts and turns on the regenerative pair of Q6 and Q7. Conduction of these transistors turns off Q2 and Q1, thus limiting the current through the pre-regulator bridge

## 3-108. Protection Circuitry

3-109. Instrument protection is afforded by several circuits; the over-voltage/over-current trip circuit, discussed with the series pass driver assembly in paragraph 3-60, the automatic and manual crowbar circuits, and the rate limiter (paragraph 3-74).

3-110. CROWBAR CIRCUITS. The automatic crowbar circuit consists of transistor Q10 in the series pass assembly, relay K1 on the high voltage assembly, and associated circuitry. When the voltage across the series pass element reaches approximately 225 volts, transistor Q10 conducts. Since relay K1 is in the collector circuit of Q10, the relay is energized, closing the contacts. With the K1 contacts closed, a discharge path is provided for the filter capacitors. The manual crowbar circuit consists of relay driver Q1 on

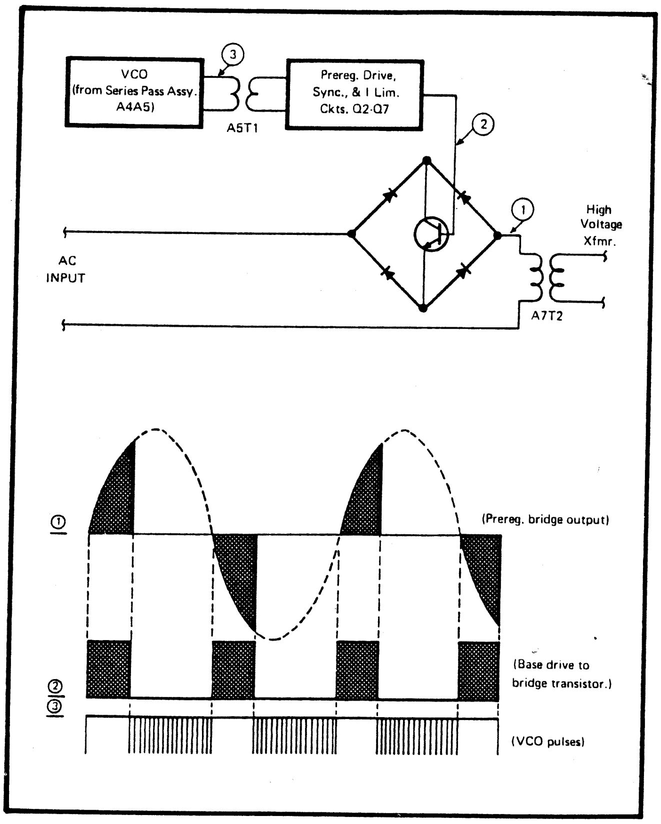



Figure 3-7. PREREGULATOR SIMPLIFIED DIAGRAM AND STYLIZED WAVEFORMS

he Relay Driver Assembly A4A9 and relay A6K2. The nstrument output is connected to the normally open :ontacts of A6K2. When the front panel CROWBAR-OFF witch is depressed, the relay is de-energized and, conse- 
uently, has no effect. When the CROWBAR-ON switch is ressed, A6K2 is energized, through the relay driver, and esistor A6R1 is placed across the output terminals to uickly discharge the output capacitors.

## 3-111. Control Circuitry and Front Mother Board

-112. The Control Circuitry for the instrument consists f four assemblies. The parent assembly is the (A3) Front Aother Board, which interconnects the (A3A1) Decade witch assembly, the (A3A2) Switch Board, and the A3A3) I Limit/V Trip assembly, and distributes the result- ng control signals to the appropriate sections of the instru- nent. Programming inputs from the rear panel Remote onnector, except for the operate, voltage trip range and ernier and current limit are parallel connected with the mit circuitry in the instrument. The Voltage Trip range determined by the relay switching circuitry. The operate ne is routed through the Front Mother Board in order or both local and remote modes of operation to be con- rolled by the inhibit circuitry which prevents the instru- nent from being turned on before being placed in standby.

·113. FRONT MOTHER BOARD (A3). The Front other Board contains the ladder networks for the remote urrent limit and voltage trip vernier control features, a eater than 100 volt output detector, the status indicator mps, and an inhibit circuit. The current limit ladder con- sts of Q5 through Q8, K2 through K5, and the remote se- ction circuit Q4 and K1. The voltage trip ladder consists Q10 through Q13, K7 through K10, and the remote se- ction circuit Q9 and K6. Transistors Q1 through Q3 form e greater than 100 volt output detector, and the status dicator lamps consist of DS1 through DS10. The cir- iitry of K11 thru K13, Q17, and Q18 form the Voltage ip range. Elements of the inhibit circuitry are IC1, Q15, d Q16.

114. The remote current limit ladder consists of relay ivers Q5 through Q8 and relays K2 through K5, a resis- e ladder network of R17, R19, R21, and R23, and the mote selection circuit of Q4 and K1. The relay drivers are entical PNP switches which are turned on by a Logic "1" to 0.5 volts) and turned off by a Logic "0" (+3.8 to 20 lts). Each transistor receives a −25 volt dc collector ltage through the associated relay which is connected terminal 22. Base voltages are dependent on the input gic signals from the Remote connector. Diodes CR7 and CR8 convert the 8-4-2-1 coded input to 4-4-2-1 code, which limits the maximum digital command to a four digit word of eleven or 110 milliamperes. The resistive ladder network is selected in various combinations by relays K2 through K5 and divides the I limit resistance at terminal 19 into weighted terms of elevenths. The remote selection circuit of Q1 and K1 is activated upon the presence of a Logic "1" remote current limit com- mand at terminal 21 and applies the ladder output to terminal 19. The current limit circuitry in the instrument receives this ladder output and limits the maximum output current to the level established by the coded inputs at terminals 43 through 46 of the Remote connector.

3-115. The remote voltage limit ladder employs relay drivers Q10 through Q13, relays K7 through K10, and the resistive ladder network of R26, R28, R30, and R32. The remote selection circuit for this network is Q9 and K6. Operation of the voltage limit ladder is essentially the same as that of the current limit ladder. Collector voltage for the relay drivers is obtained from the −25 volt source in the same manner described for the current limit ladder. CR9 and CR10 perform the 8-4-2-1 to 4-4-2-1 decoding. The ladder output appears at the remote contact of K6 and is coupled through R40 to the base of emitter follower Q14. The output is developed across R41 and appears on terminal 92.

3-116. The Voltage Trip Range circuitry is composed of K11 thru K13 and associated elements. Relay K13 is a "Local-Remote" relay for this circuit and is energized by Q9. With pins 3 and 4 held at Logic "0", the 10 volt trip range is activated. When a Logic "1" is applied to Q17, the 100 volt trip range is called; with the base of Q17 held at a Logic "0" and a Logic "1" applied to Q18, the 1000 volt trip range is in effect. Both relay drivers are PNP switches that are identical to the current limit and voltage trip switches.

3-117. The greater than 100 volt output detector of Q1, Q2 and Q3 samples the output and illuminates DS6 when the output voltage exceeds 100 volts. This provides a visual indication that the instrument has output voltages present that require caution in their application.

3-118. The configuration of Q15, Q16, and quad NOR gate IC1 forms an inhibit circuit which prevents the instru- ment from going into operate before passing through stand- by. Refer to Figure 3-8 for a simplified diagram of this cir- cuit. The flip-flop is set initially to the proper state by the Logic "1" coming from S2 on the Switch Board (A3A2), when the standby position is selected. Should the instru- ment be in the operate mode when the power is turned on, the flip-flop will be in the wrong state due to the Logic "0" from A3A2S2. A Logic "0" must be present at the output of the flip-flop (pin IC1 14) when the operate-mode is selected; otherwise it is impossible to energize the instrument output's. If a Logic "1" (zero volts) is present at pin 14 when the operate mode is selected, Q15 and Q16 will turn on, holding the operate line down to nearly zero volts. The instrument must then be placed in the standby mode to set the flip-flop before the operate mode can be selected.

3-119. The indicator lamps provide visual indications of the instruments status while in local mode. The lamps and their function are:

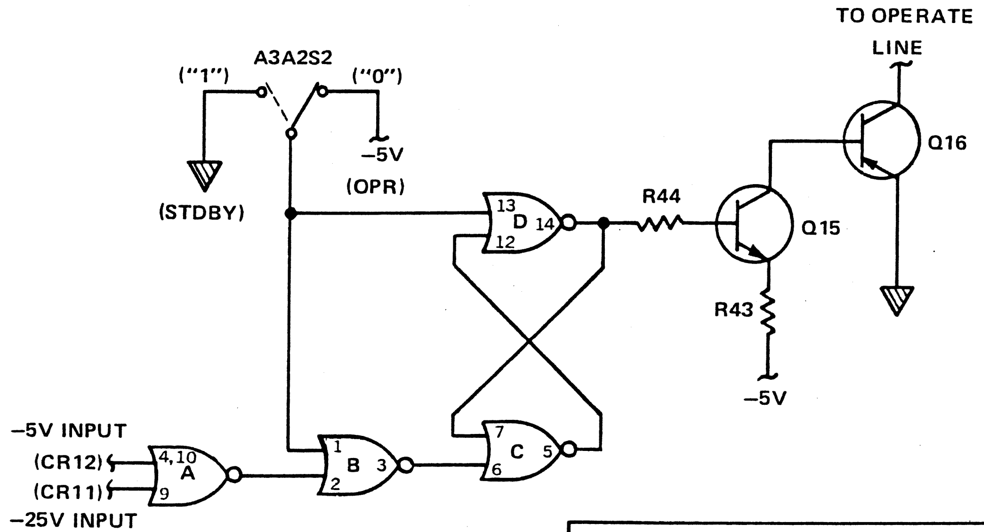
| | |
|---|---|
| DS1, DS2, DS3, DS4 | Provide decimal point indication in association with the front panel Decade Dials. |
| DS5 | I LIMIT/V TRIP indicates limit or trip mode |
| DS6 | OUTPUT > 100v |
| DS7 | CONSTANT CURRENT |
| DS8 | CONSTANT VOLTAGE |
| DS9 | OPR operate mode |
| DS10 | REM remote mode |

3-120. DECADE SWITCH ASSEMBLY (A3A1). This assembly contains the seven decade switches used to select the desired output current or voltage while in local mode. Each switch is an eleven position switch; the highest order, S1, has positions ranging from 0 to 10, while the remaining switches S2 through S7 have a range of 0 to X. The "X" indicates a "carry one" function, so that an output voltage of, for example, 1100,0000 volts would be dialed as 10X0.0000.

3-121. On the schematic diagram the switches are shown for representation as 5 position switches, the positions being 8, 4, 2, 1, and 0 with numbers in parenthesis by the positions. The 8-4-2-1 corresponds to the BCD coding applied to the ladders. On S2 position 1, for example, the numbers 1, 3, 5, 7, 9, in parenthesis indicate that CR5 is connected to the wiper arm in the decade settings 1, 3, 5, 7, and 9.

3-122. The wiper arm of each switch is connected to −5 volts. The four outputs of each switch are connected to the appropriate relay driver in the ladder drive assembly.

3-123. SWITCH BOARD (A3A2) This assembly contains the front panel push button switches used to activate the various conditions in the instrument. The groups of




| NOR FUNCTION DEFINED | | |
|---|---|---|
| INPUTS | | OUT |
| 1 | 1 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 0 | 1 |

Where:
1 = Zero Volts
0 = 3.6 to −20 Volts
(In this application).

| CONDITION | | GATE OUTPUTS A | B | C | D |
|---|---|---|---|---|---|
| Initially in Standby | −25V not yet on | 0 | 0 | 1 | 0 |
| | −25V now on | 1 | 0 | 1 | 0 |
| | Switched to OPR | 1 | 0 | 1 | 0 |
| Initially in Operate | −25V not yet on | 0 | 1 | 0 | 1 |
| | −25V now on | 1 | 0 | 0 | 1 |

INHIBIT CIRCUIT TRUTH TABLE

(ground symbol) = PROGRAMMING SUPPLY COMMON

Figure 3-8. INHIBIT CIRCUIT

switches are mechanically linked so that if one switch in the group is depressed, the remaining non-appropriate switches are pushed into the non-depressed positions.

3-124. I LIMIT/V TRIP VERNIER (A3A3). Two variable resistors (R1 and R2) form this assembly. Both are front panel adjustments; R1 is the voltage limit trip, and R2 is the current limit vernier. Mechanically, the wiper arms form a sliding arrangement to allow selection of settings from LO to HI on the front panel.

## 3-125. Relay Board (A6)

3-126. Two relays are found on this assembly. K1, the operate relay, and K2, the Manual Crowbar relay.

## 3-127. Inner Chassis (A7)

3-128. Contained within the Inner Chassis assembly are three transformers arranged in a bracket. T1 is the primary power distribution transformer. T2 supplies ac power to the High Voltage Supply (A4A6) and obtains its input from the Pre-regulator (A5A2). T3 supplies power to the −25 and −5 volt Power Supply (A5A1).

## 3-129. Relay Summary

3-130. Figure 3-9 is provided to summarize the relays found in the 3330B. The decade ladder relays, current limit and voltage trip range ladder relays, and the time delay relay A5A1K1 are not included in the illustration.

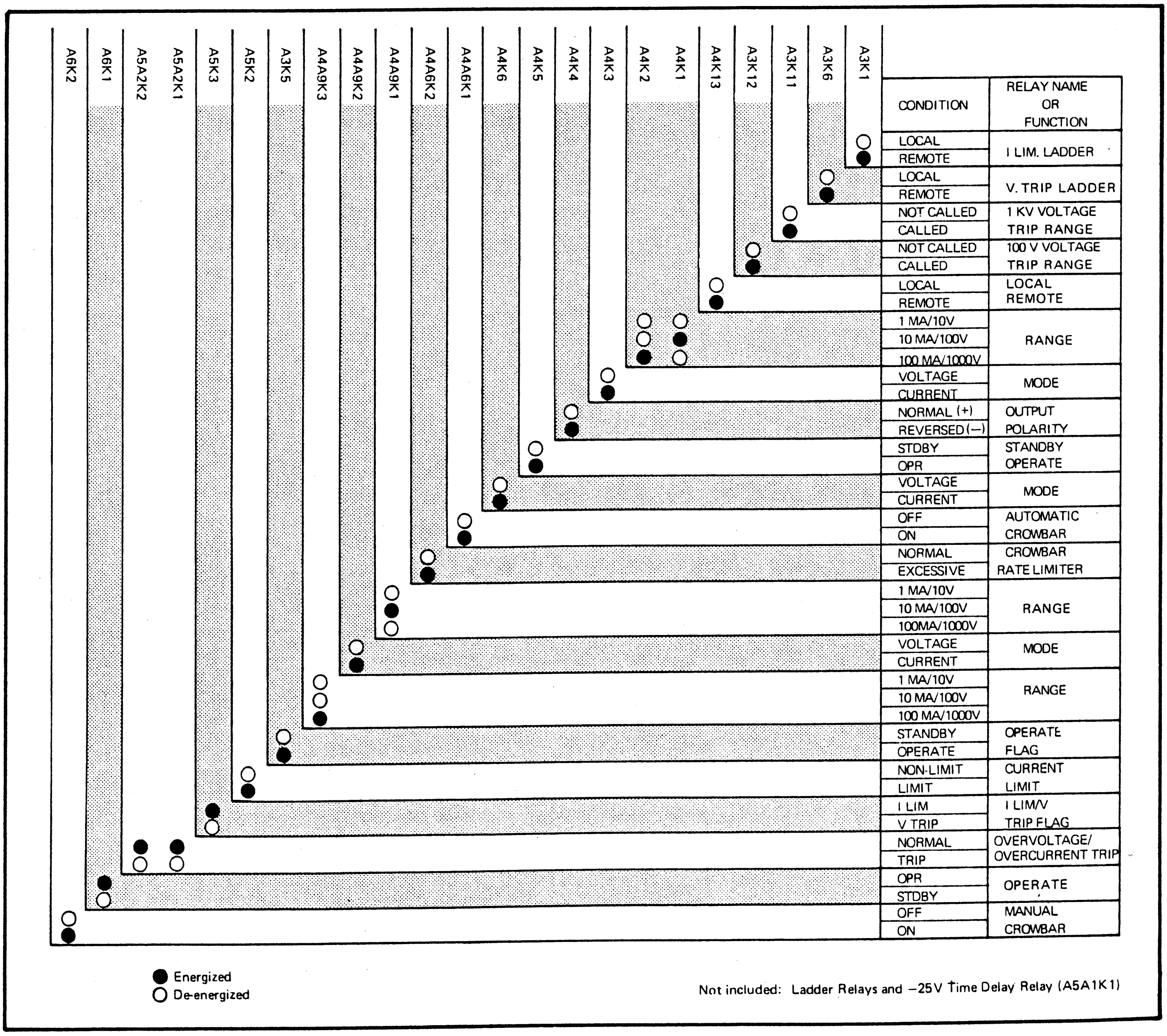



Figure 3-9. RELAY SUMMARY

# Section 4
# Maintenance

## 4-1. INTRODUCTION

4-2. This section of the manual contains servicing and maintenance information for the Model 3330B. The information is arranged under headings of "SERVICE INFORMATION, GENERAL MAINTENANCE, PERFORMANCE CHECKS, CALIBRATION, and TROUBLESHOOTING". Table 4-1 lists the recommended test equipment. If the recommended items are not available, substitute equipment having equivalent specifications can be used.

Table 4-1. REQUIRED TEST EQUIPMENT

| EQUIPMENT NOMENCLATURE | RECOMMENDED EQUIPMENT | | TEST FUNCTION |
|---|---|---|---|
| Autotransformer | Variac | | Performance Checks<br>Calibration<br>Troubleshooting |
| DC Voltmeter | Fluke Model 895A | | Performance Checks<br>Calibration<br>Troubleshooting |
| DC Voltage/Ratio Calibration System | Fluke Model 7105A<br>Differential Voltmeter<br>Power Supply Calibration<br>Stability Measurement | | Performance Checks<br>Calibration |
| Oscilloscope | Tektronix Model 545B | | Calibration<br>Troubleshooting |
| Preamplifier | Gain X1000 | | Performance Checks |
| RMS Voltmeter | Fluke Model 931B | | Performance Checks<br>Calibration |
| STANDARD RESISTORS:<br>10Ω, 0.2W<br>100Ω, 0.02W<br>1K, 0.002W | LEEDS & NORTHRUP STDS.<br>4025-B<br>4030-B<br>4035-B | | Performance Checks<br>Calibration |
| RESISTIVE LOADS | 100, ±5%, 2W<br>1K, ±5%, 20W<br>2K, ±5%, 5W<br>5K, ±10%, 50W | 10K ±10%, ¼W<br>20K ±5%, 50W<br>100K ±10%, 20W<br>1M ±10%, 2W | Performance Checks<br>Calibration<br>Troubleshooting |

## 4-3. SERVICE INFORMATION

4-4. All products manufactured by the John Fluke Mfg. Co., Inc. are warranted for a period of one year. Complete warranty information is located in the WARRANTY at the front of the manual.

4-5. Factory authorized calibration and service for all Fluke products is available at various world-wide locations. A complete list of Factory Authorized Service Centers is located at the rear of the manual. If requested, an estimate will be provided before repair work is done on an instrument that is beyond the warranty period.

## 4-6. GENERAL MAINTENANCE

### 4-7. Cleaning

4-8. The Model 3330B should be cleaned periodically to remove dust, grease, or other contaminates. Care has been taken in design to prevent leakage through the use of high quality insulation materials on all switches. Special attention has also been given to component locations. All circuit boards, with the exception of the A4A6 H. V. Power Supply, have been coated with a moisture sealant to inhibit fungus growth.

4-9. EXTERIOR CLEANING. To clean the exterior, use a cloth moistened with anhydrous ethyl alcohol or Freon T.F. Degreaser (MS180 Miller Stephensen Chemical Co., Inc.). If either of these cleaning agents are not readily available, soap and water applied sparingly to a cloth can be used.

4-10. INTERIOR CLEANING. Use clean, dry air at low pressure to remove loose contamination from the interior sections of the Model 3330B.

### 4-11. Fuse Replacement

4-12. Two fuses are located on the rear panel. Fuse F1 protects the programming circuitry, and F2 protects the input power circuitry. If replacement is necessary, use the following types of fuses:

| | |
|---|---|
| F1 | 1/8 FAST-BLO (115/230 vac) |
| F2 | 3A SLO-BLO (115 vac)<br>1.5A SLO-BLO (230 vac) |

### 4-13. Lamp Replacement

4-14. Status indicator lamps are located on the front panel. These lamps are accessible from the top of the instrument after removal of the top dust cover and front trim strip. The lamps are easily removed and replaced with no special tools. If replacement is necessary, use GE 7387 lamps (or equivalent), FLUKE PART NO. 246686.

## 4-15. PERFORMANCE CHECKS

### 4-16. Introduction

4-17. The following checks can be used to verify the electrical characteristics of the Model 3330B. These checks can also be used for receiving inspection, periodic inspection, and precalibration checks.

4-18. When performing these checks, it is not necessary to remove the covers from the instrument. All test equipment is connected to the OUTPUT terminals. Table 4-1 lists the required test equipment for these checks.

*NOTE!*

*If a malfunction is discovered during the performance checks, complete as many tests as possible and record the abnormal indications. This information can then be used to more efficiently troubleshoot the instrument.*

### 4-19. Line/Load Regulations Checks

4-20. VOLTAGE MODE. This check will determine if the output voltage remains constant for a combined ±10% line voltage and full-load change.

a. Connect the Model 3330B power cord to an autotransformer set for an output of 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STDBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 1.000000 |

c. Connect a dc voltmeter to the OUTPUT terminals, observing proper polarity.

d. Select the OPR mode and perform the checks given in Table 4-2. The output voltage must be within the specified limits. Output loads are listed in Table 4-1.

Table 4-2. VOLTAGE MODE REGULATION CHECKS

| STEP | MODEL 3330B CONTROL SETTINGS | | OUTPUT LOAD | INPUT POWER (VAC) | OUTPUT VOLTAGE |
|---|---|---|---|---|---|
| | RANGE | DECADE DIALS | | | |
| 1 | 10 | 1.000000 | NONE | 115 | RECORD |
| 2 | 10 | 1.000000 | NONE | 103 thru 127 | ±20 uv of step 1 |
| 3 | 10 | 1.000000 | 10Ω, 0.2W | 115 | ±20 uv of step 1 |
| 4 | 10 | 1.000000 | 10Ω, 0.2W | 103 thru 127 | ±20 uv of step 1 |
| 5 | 1000 | 1000.0000 | NONE | 115 | RECORD |
| 6 | 1000 | 1000.0000 | NONE | 103 thru 127 | ±5 mv of step 5 |
| 7 | 1000 | 1000.0000 | 20K, 50W | 115 | ±5 mv of step 5 |
| 8 | 1000 | 1000.0000 | 20K, 50W | 103 thru 127 | ±5 mv of step 5 |

*NOTE!*

*If desired, each range can be checked at 1/10 and full-scale outputs using the procedure given in Table 4-2. Loads are listed in Table 4-1.*

e. Select the STDBY/RESET mode.

4-21. MA MODE. This check will determine if the output current remains constant for a combined ±10% line voltage and full load change.

a. Connect the Model 3330B power cord to an autotransformer set for an output of 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .10000000 |

c. Make the equipment connections shown in Figure 4-1. $R_L$ is 1M, 2W and $R_s$ is a 1K, 0.002W Standard. All connecting leads must be pure copper with spade lugs.

d. Select the OPR mode and perform the checks given in Table 4-3. The output current (Rs voltage) should be within the specified limits.

e. Select the STDBY/RESET mode.

## 4-22. Ripple Checks

4-23. VOLTAGE MODE. This check provides a means of verifying that ac components superimposed on the constant voltage output are within the specified limits.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 10.000000 |

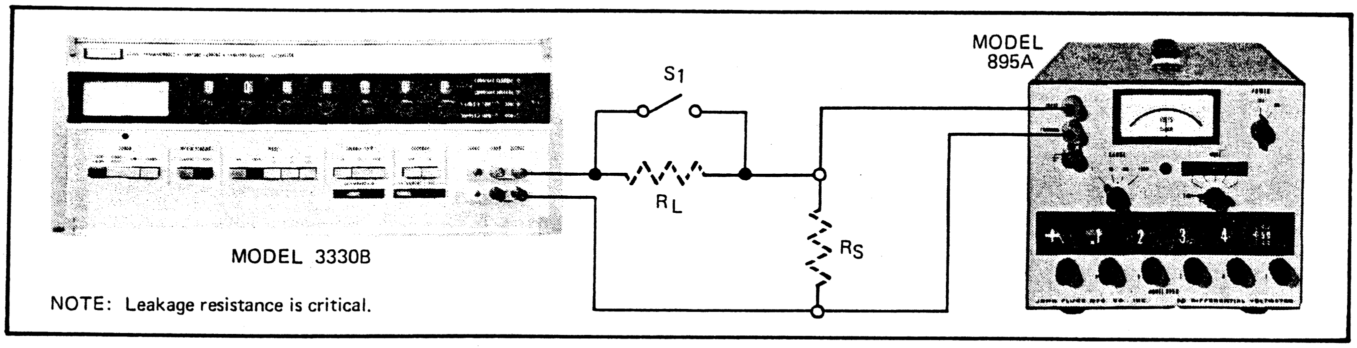



Figure 4-1. MA MODE REGULATION CHECK-EQUIPMENT CONNECTIONS

c. Connect a x1000 Preamplifier to the Model 3330B OUTPUT terminals. Also connect an rms voltmeter to the Preamplifier output.

d. Select the OPR mode and perform the checks given in Table 4-4. Specified ripple indications in Table 4-4 include the gain of the Preamplifier.

e. Select the STDBY/RESET mode.

4-24. MA MODE. This check provides a means of verifying that ac components on the constant current output are within specified limits.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .0000000 |

c. Connect a 10K ±10%, 1 watt load to the OUTPUT terminals. Also connect the GUARD terminal to the common side of the load.

d. Connect a X1000 Preamplifier to the OUTPUT terminals. Connect an rms voltmeter to the Preamplifier output.

e. Select the OPR mode, observing that the rms voltmeter indication is less than 200 uv.

f. Select the 10MA range, observing that the rms voltmeter indication is less than 1.0 mv.

g. Disconnect the Preamplifier, and then connect the rms voltmeter directly to the Model 3330B OUTPUT terminals. The rms voltmeter indication should be less than 10 mv.

h. Select the STDBY/RESET mode.

## 4-25. Accuracy Checks

4-26. VOLTAGE MODE. The accuracy of the output voltage can be verified in the following manner:

Table 4-3. MA MODE REGULATION CHECKS

| STEP | MODEL 3330B CONTROL SETTINGS | | OUTPUT LOAD | | INPUT POWER (VAC) | S1 POSITION | OUTPUT CURRENT ($R_s$ VOLTAGE) |
|---|---|---|---|---|---|---|---|
| | RANGE | DECADE DIALS | RL | $R_s$(Std) | | | |
| 1 | 1 | .10000000 | 1M, 2W | 1K | 115 | Closed | RECORD |
| 2 | 1 | .10000000 | 1M, 2W | 1K | 103 thru 127 | Open | ±20 uv of step 1 |
| 3 | 10 | 10.000000 | 100K, 20W | 100Ω | 115 | Closed | RECORD |
| 4 | 10 | 10.000000 | 100K, 20W | 100Ω | 103 thru 127 | Open | ±5 uv of step 3 |
| 5 | 100 | 100.00000 | 5K, 50W | 10Ω | 115 | Closed | RECORD |
| 6 | 100 | 100.00000 | 5K, 50W | 10Ω | 103 thru 127 | Open | ±5 uv of step 5 |

Table 4-4. VOLTAGE MODE RIPPLE CHECKS

| STEP | MODEL 3330B CONTROL SETTINGS | | OUTPUT LOAD | MAXIMUM RIPPLE RMS (X1000) |
|---|---|---|---|---|
| | RANGE | DECADE DIALS | | |
| 1 | 10 | 10.000000 | NONE | 60 mv |
| 2 | 10 | 10.000000 | 100Ω, 2W | 0.1v |
| 3 | 100 | 100.00000 | NONE | 70 mv |
| 4 | 100 | 100.00000 | 1K, 20W | 0.1v |
| 5 | 1000 | 1000.0000 | NONE | 0.1v |
| 6 | 1000 | 1000.0000 | 20K, 50W | 0.1v |

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 5.000000 |

c. Connect a power supply calibrator (Fluke Model 7105A System) to the Model 3330B OUTPUT terminals.

d. Select the OPR mode and perform the checks given in Table 4-5A. The output voltage should be within the specified limits.

e. Select the STDBY/RESET mode.

4-27. MA MODE. The accuracy of the output current can be verified in the following manner:

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .1000000 |

c. Make the equipment connections shown in Figure 4-2. The $R_{STD}$ resistor is a 1K, 0.001W.

d. Select the OPR mode and perform the checks given in Table 4-5B. The output current ($R_{std}$ voltage) should be within specified limits.

e. Select the STDBY/RESET mode.

## 4-28. Stability Checks

4-29. VOLTAGE MODE. This check will determine if the output voltage remains constant over a given period of time.

a. Connect the Model 3330B power cord to 115 vac.

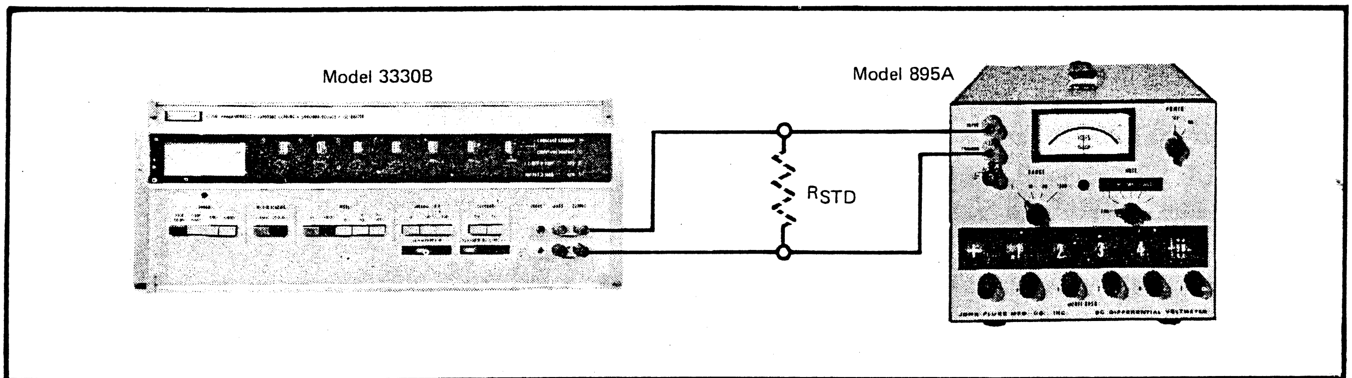



Figure 4-2. MA MODE ACCURACY CHECK – EQUIPMENT CONNECTIONS

Table 4-5A. VOLTAGE MODE ACCURACY CHECKS

| STEP | MODEL 3330B CONTROL SETTINGS | | OUTPUT VOLTAGE (VDC) |
|---|---|---|---|
| | RANGE | DECADE DIALS | |
| 1 | 10 | 5.000000 | 5 ± 0.15 mv |
| 2 | 10 | 10.000000 | 10 ± 0.3 mv |
| 3 | 100 | 10.00000 | 10 ± 0.3 mv |
| 4 | 100 | 50.00000 | 50 ±1.5 mv |
| 5 | 100 | 100.00000 | 100 ± 3 mv |
| 6 | 1000 | 100.0000 | 100 ± 3 mv |
| 7 | 1000 | 500.0000 | 500 ± 15 mv |
| 8 | 1000 | 1000.0000 | 1000 ± 30 mv |

Table 4-5B. MA MODE ACCURACY CHECKS

| STEP | MODEL 3330B CONTROL SETTINGS | | $R_{STD}$ | OUTPUT CURRENT ($R_{STD}$ VDC) |
|---|---|---|---|---|
| | RANGE | DECADE DIALS | | |
| 1 | 1 | .1000000 | 1K | 0.1 ± 6 uv |
| 2 | 1 | .5000000 | 1K | 0.5 ± 30 uv |
| 3 | 1 | .10000000 | 1K | 1.0 ± 60 uv |
| 4 | 10 | 1.000000 | 100Ω | 0.1 ± 6 uv |
| 5 | 10 | 5.000000 | 100Ω | 0.5 ± 30 uv |
| 6 | 10 | 10.000000 | 100Ω | 1.0 ± 60 uv |
| 7 | 100 | 10.00000 | 10Ω | 0.1 ±6 uv |
| 8 | 100 | 50.00000 | 10Ω | 0.5 ± 30 uv |
| 9 | 100 | 100.00000 | 10Ω | 1.0 ± 60 uv |

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 1000 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 1000.0000 |

c. Select the OPR mode and allow the Model 3330B to operate for at least one hour. The ambient room temperature must be 23°C, ±1°C.

d. Select the STDBY/RESET mode and connect a DC Voltage Stability Measurement System (FLUKE Model 7105A) to the OUTPUT terminals.

e. Select the OPR mode. After 24 hours the output voltage should not change more than ±5 mv.

f. Select the STDBY/RESET mode.

4-30. MA MODE. This check will determine if the output current remains constant over a given period of time.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 10.000000 |

c. Make the equipment connections shown in Figure 4-1. $R_L$ is 100K, 20W, and $R_s$ is a 100Ω Standard

*NOTE!*

*S1 must be open*

d. Select the OPR mode and allow the Model 3330B to operate for at least one hour. The ambient room temperature must be 23°C, ±1°C.

e. Connect a chart recorder to the dc voltmeter RECORDER OUTPUT terminals and establish a reference which is the voltage across $R_S$.

f. Operate the equipment for 24 hours. The output current should not change more than ±0.1 ua during this period. This is equal to a voltage change of less than ±10 uv across $R_S$.

## 4-31. Voltage Trip Checks

4-32. This check provides a means of verifying that the VOLTAGE TRIP is functioning properly.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 100 |
| VOLTAGE TRIP | 100, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 100.00000 |

c. Select the OPR mode. The OPR lamp should be illuminated.

d. Advance the Decade Dials to 10X.XX000. When this new setting is reached, the I LIMIT/V TRIP lamp should illuminate and the OPR lamp should go out.

e. Select the STDBY/RESET mode and set the Decade Dials to 10X.00000.

f. Select the OPR mode. The OPR lamp should be illuminated.

g. Select the STDBY/RESET mode.

## 4-33. Current Limit Checks

4.34. This check provides a means of verifying that the CURRENT LIMIT is functioning properly.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 100 |
| VOLTAGE TRIP | 100, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | ON |
| Decade Dials | 100.00000 |

c. Select the OPR mode.

d. Advance the Decade Dials to 10X.X0000. When this new setting is reached, the I LIMIT/V TRIP lamp should just illuminate.

e. Set the Decade Dials to 01.00000. The I LIMIT/V TRIP lamp should be off.

f. Slide the CURRENT LIMIT control towards the LO setting. The I LIMIT/V TRIP lamp should just illuminate when the LO position is reached.

g. Select the STDBY/RESET and CROWBAR OFF modes.

## 4-35. Rate Limiter Checks

4-36. This check provides a means of verifying that the programming rate limiter is functioning properly.

a. Connect the Model 3330B power cord to 115 vac.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 1000 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 1000.0000 |

c. Select the OPR mode.

d. Alternately select the 10 and 1000 volt ranges at a rate greater than once every 5 seconds. The I LIMIT/V TRIP lamp should illuminate, and the OPR lamp should go out.

e. Select the STDBY/RESET mode and then the OPR mode. The OPR lamp should be illuminated.

f. Select the STDBY/RESET mode.

## 4-37. Remote Programming Checks

4-38. Complete verification of all remote programming functions should be done before the Model 3330B is considered fully operational. Information located in the Section II, Operating Instructions, can be used to check these functions.

## 4-39. CALIBRATION

### 4-40. Introduction

4-41. The Model 3330B should be calibrated every 90 days or whenever repairs have been made. Calibration should be done at an ambient room temperature of 23°C, ±1°C. Table 4-1 lists the required test equipment.

### 4-42. Maintenance Access

4-43. To gain access to the calibration adjustments, proceed as follows:

a. Turn off the Model 3330B.

b. Remove the top dust cover and inner cover. Access is now provided to the calibration adjustments and test points shown in Figure 4-3.

*NOTE!*

*The interlock switch shown in Figure 4-3 must be closed before the instrument can be energized with the covers removed.*

### 4-44. Servicing Tools

4-45. Special tools are provided for servicing of the plug-in assemblies. These tools consist of a card puller ring and an extender card. The card puller ring is located in a container shipped with the instrument. The extender card is mounted in a plastic holder on the rear panel. To service a plug-in assembly, proceed as follows:

a. Perform the Maintenance Access procedures in paragraph 4-42.

b. Locate the assembly to be removed and insert the card puller ring in the hole at the top of the board. Refer to Figure 4-3 for assembly locations.

c. Insert your index finger in the card puller ring and remove the plug-in assembly using a gentle rocking and even pulling force.

d. Install the extender card in the assembly position. Ensure that the mating connectors are correctly aligned.

e. Install the plug-in assembly on the extender card. The mating connectors must be correctly aligned with the same configuration as that in the instrument.

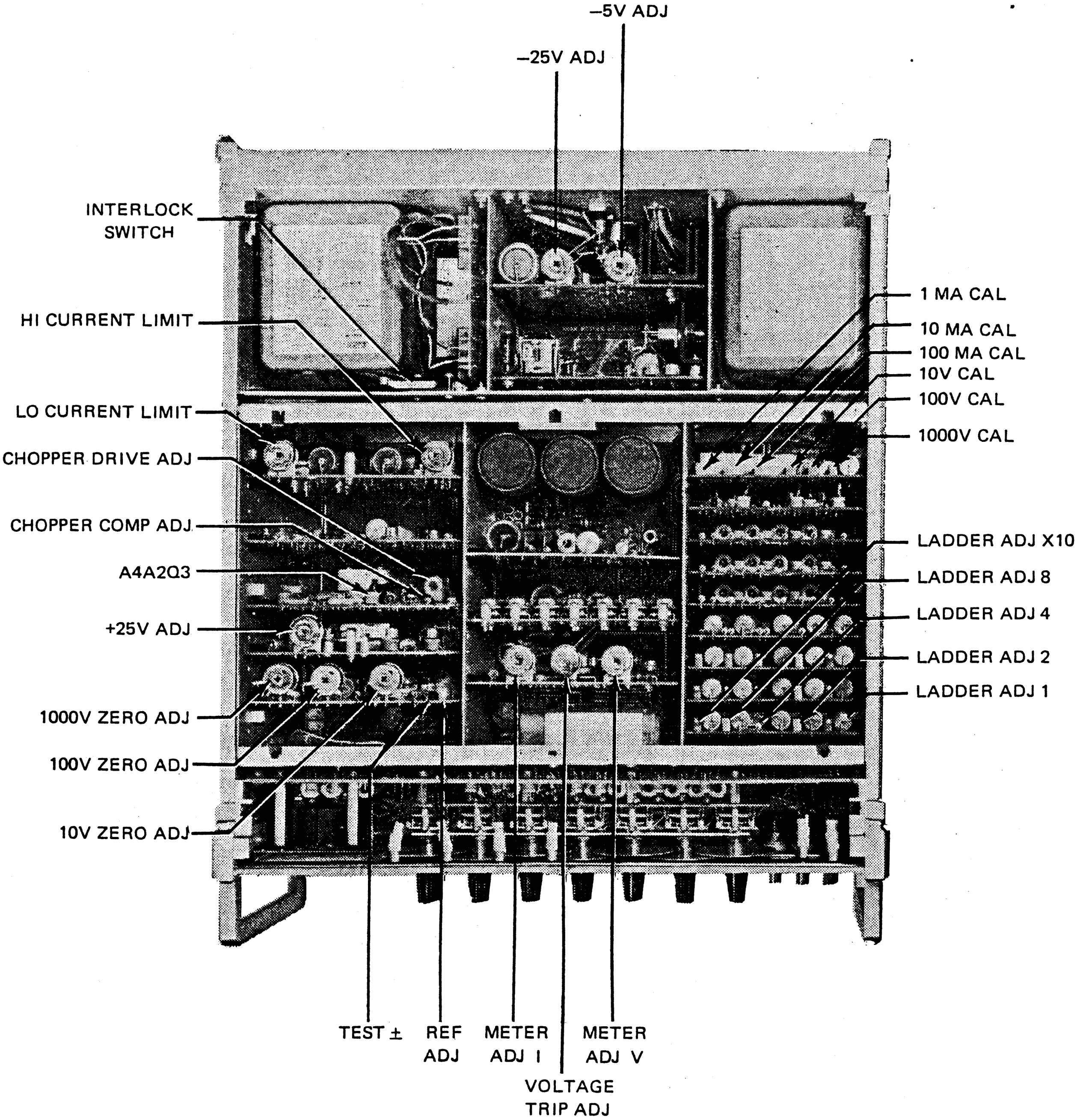



Figure 4-3. ADJUSTMENT, TEST POINT AND ASSEMBLY LOCATIONS (Sheet 1 of 2)

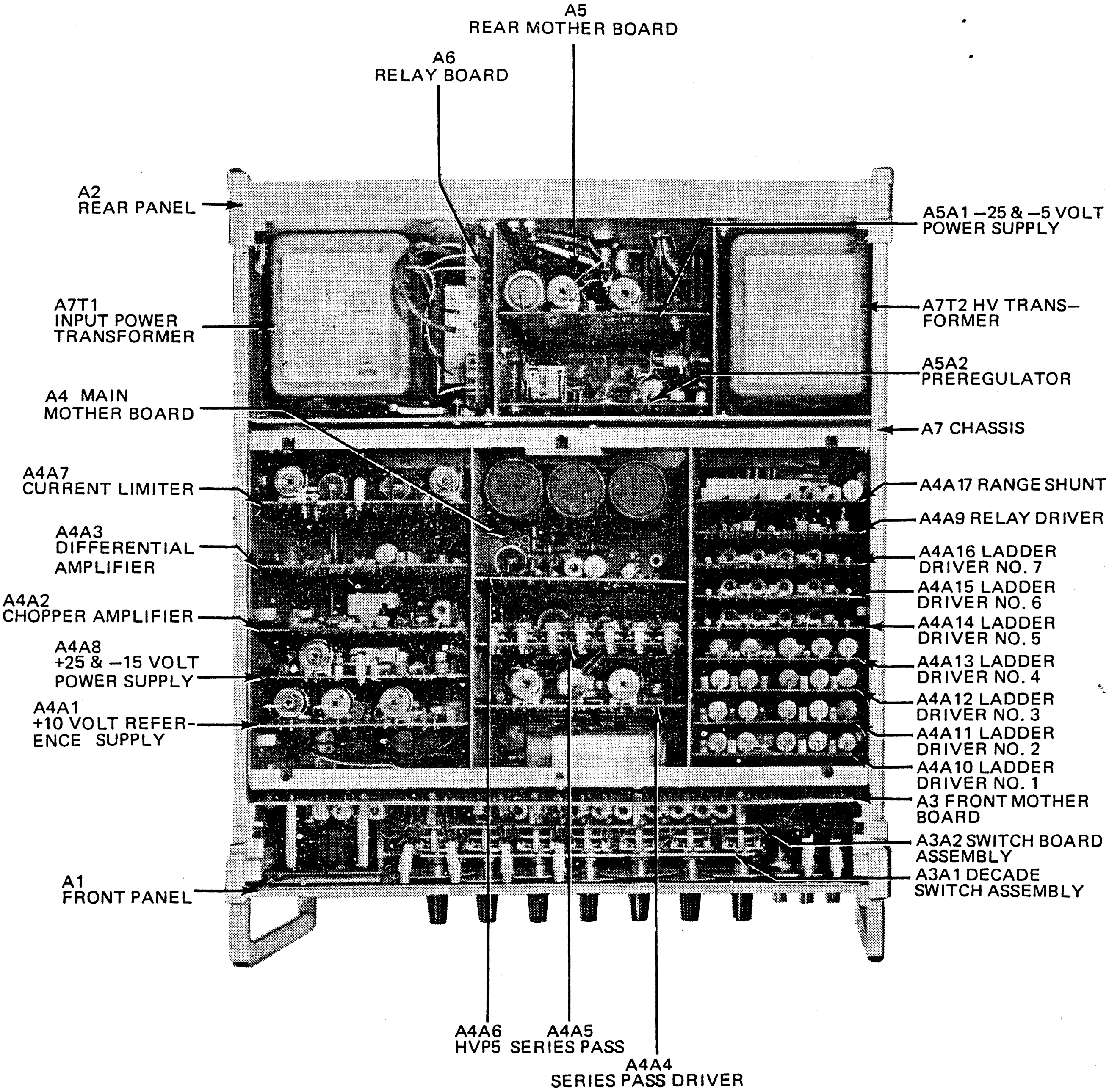



Figure 4-3. ADJUSTMENT, TEST POINT AND ASSEMBLY LOCATIONS (Sheet 2 of 2)

## 4-46. Preliminary Calibration Procedures

a. Perform the Maintenance Access procedures given in paragraph 4-42.

b. Connect the Model 3330B power cord to 115 vac.

c. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 0.000000 |

d. Select the OPR mode and allow the Model 3330B to operate for at least one hour.

## 4-47. +25 and −5 VDC Alignment

a. Install the A4A8 assembly on the extender card.

b. Connect the input of a dc voltmeter to A4A8 terminal 10 and its common to the +SENSE terminal.

c. Turn on the Model 3330B and select the STDBY/RESET mode.

d. Adjust A4A8R9, +25V ADJ, for a 25 ±0.01 vdc indication ont he voltmeter.

e. Turn off the Model 3330B and install the A4A8 assembly.

f. Install the A5A1 assembly on the extender card.

g. Connect the input of a dc voltmeter to A5A1 terminal 6 and its common to terminal 5.

h. Turn on the Model 3330B and select the STDBY/RESET mode.

i. Adjust A5A1R5, −25V ADJ, for a −25 ±0.025 vdc indication on the voltmeter.

j. Connect the dc voltmeter input to A5A1 terminal 16.

k. Adjust A5A1R11, −5V ADJ, for −5 ±0.01 vdc indication on the voltmeter.

l. Turn off the Model 3330B and install the A5A1 assembly.

## 4-48. Chopper Amplifier Alignment

a. Remove the A4A2 Chopper Amplifier PCB Assembly from its slot and install a jumper wire between pins 6 and 12 on the pcb.

b. Install the extender pcb in the Chopper Amplifier slot, and install the Chopper Amplifier PCB on the extender.

c. On the front panel of the 3330B connect the positive output terminal (red) to the chassis ground terminal.

d. Refer to Figure 4-4 and connect a X1 scope probe to the negative side of C13 on the Chopper Amplifier PCB. Connect the probe's ground lead to the main chassis (not the guard chassis).

e. Connect the 3330B to line power and sequentially depress the ON-OFF and STDBY RESET switches.

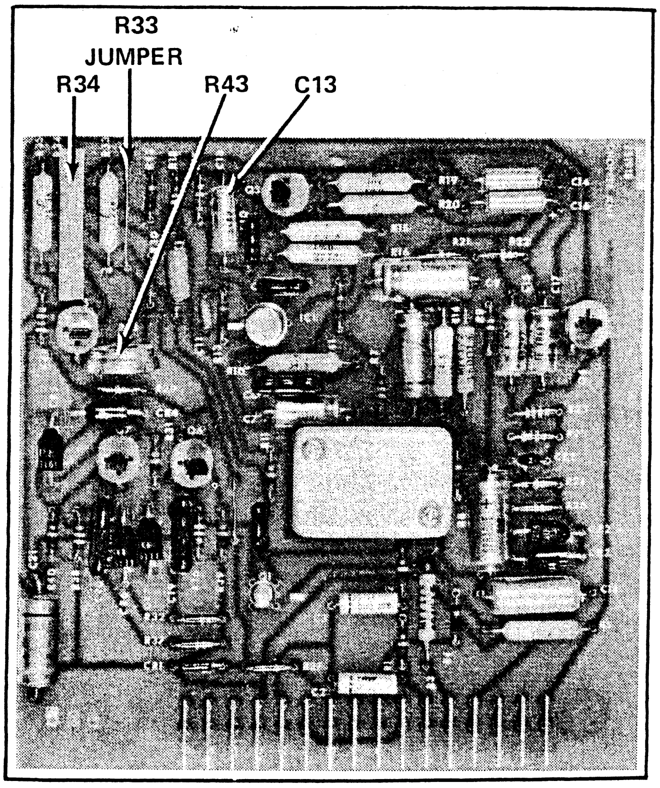



Figure 4-4. CHOPPER AMPLIFIER ADJUSTMENTS AND TEST POINTS

f. Set the scopes vertical sensitivity to 1V per division and its horizontal time base to 500 us per division. Use dc coupling and adjust the trace so that zero volts is at the center of the display.

g. Refer to Figure 4-4 and adjust R43 (chopper drive) to its maximum CW position.

h. On the scope, observe a low level signal which is interrupted approximately every 2 ms by a spike.

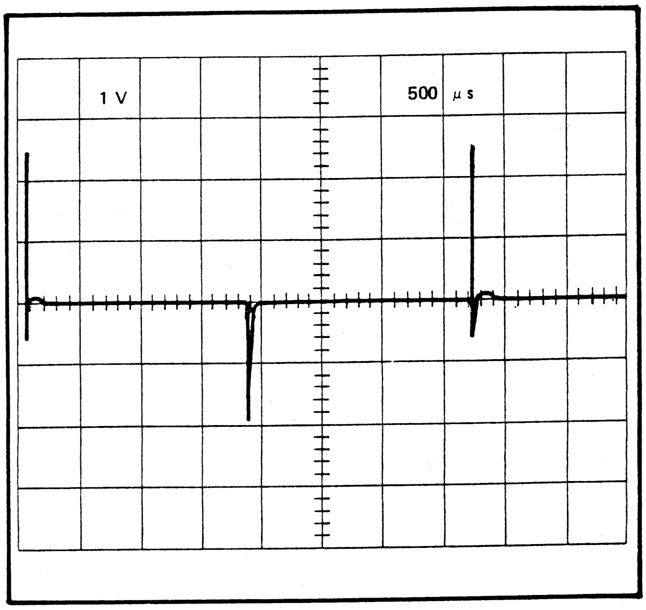



Figure 4-5. CHOPPER WAVEFORM – INITIAL ADJUSTMENT

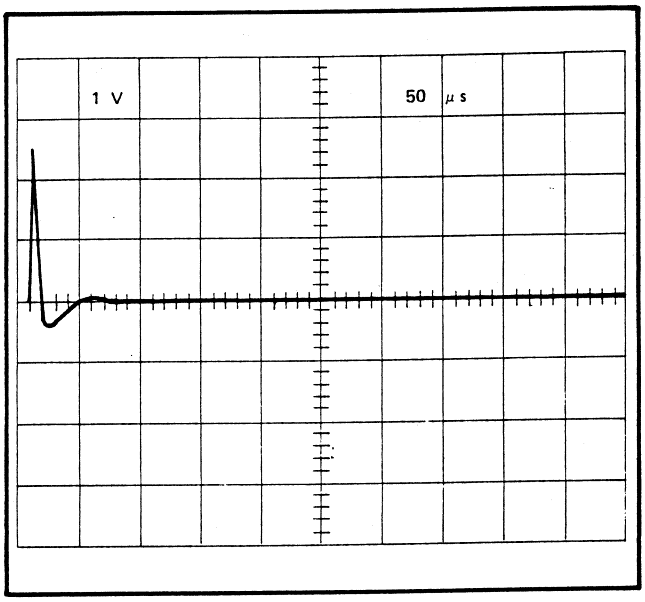



Figure 4-6. CHOPPER WAVEFORM – FINAL ADJUSTMENT

i. Adjust R43 in a CCW direction until the noise on the alternate 2 ms segments appears to be equal. From this point, adjust R43 one-quarter of a turn in the CW direction. One segment should appear noisy and the other quiet.

j. Adjust R34 so that the noisy segment is preceded by a positive-going spike similar to that shown in Figure 4-5. If the adjustment cannot be made, either install or remove the jumper across R33 (See Figure 4-4) and readjust R34 to obtain the specified display.

k. Decrease the scopes time base to 50 us per division, and fine tune R34 so that the area under the spike preceding the noisy region is equal to the area under the negative overshoot as shown in Figure 4-6.

l. Remove the jumper wire from pins 6 and 12.

m. Set the front panel dials to 0.00000 and select the 10V range.

n. Depress the OPR (operate) switch.

o. Set the scope's time base to 1 sec per division. There should be no evidence of low frequency oscillations (1 to 5 Hz) on the display. If oscillations do occur, turn R43 CW until the oscillations have stopped. Then continue to advance R43 for another one-quarter of a turn in the CW direction. Readjust R34 in accordance with steps j and k of this procedure.

p. Turn the 3330B off, remove the probe and re-install the Chopper Amplifier PCB in its slot.

## 4-49. Current Ripple Compensation

a. Connect the input of an rms voltmeter to the –OUTPUT terminal and its common to the +OUTPUT terminal.

b. Connect a 10K ±10%, 1/4W resistor between the ±OUTPUT terminals.

c. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .0000000 |

d. Select the OPR mode and adjust A7R1 for minimum rms voltage at the OUTPUT terminals.

e. Select the STDBY/RESET mode and disconnect the test equipment.

## 4-50. Range Zero Alignment.

a. Connect the input of a dc voltmeter to the OUTPUT terminals, observing proper polarity.

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, OPR |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 0.000000 |

c. Adjust A4A1R19, 10V ZERO ADJ, for a 0 ±2 uv indication on the voltmeter.

d. Select the 100 volt range and adjust A4A1R21, 100V ZERO ADJ, for a 0 ±20 uv indication on the voltmeter.

e. Select the 1000 volt range and adjust A4A1R20, 1000V ZERO ADJ, for a 0 ±0.2 mv indication on the voltmeter.

### 4-51. 10 Volt Reference Alignment

a. Select the 10 volt range.

b. Connect the input of a dc voltmeter to the TEST ± points on the A4A1 assembly.

c. Adjust A4A1R10, REF ADJ, for a 10V ±10 uv indication on the voltmeter.

d. Disconnect the voltmeter.

### 4-52. Ladder Alignment

a. Select the 100 volt range.

b. Connect the input of a dc voltmeter to the OUTPUT terminals, observing proper polarity.

c. Perform the adjustments in Table 4-6.

Table 4-6. LADDER ADJUSTMENT ①

| DECADE DIALS | ADJUSTMENT (A4A10) | VOLTMETER INDICATION (VDC) |
|---|---|---|
| 40.00000 | A4A17R18 100V CAL | 40V ± 40 uv |
| 80.00000 | R4 LADDER ADJ 8 | 80V ± 80 uv |
| 20.00000 | R8 LADDER ADJ 2 | 20V ± 20 uv |
| 10.00000 | R10 LADDER ADJ 1 | 10V ± 10 uv |
| 0X.00000 | R2 LADDER ADJ X10 | 10V ± 10 uv |

d. Select the STDBY/RESET mode and then exchange the positions of Ladder Driver No. 1 and No. 2 (A4A10 and A4A11).

e. Select the OPR mode and perform the adjustments in Table 4-7.

f. Select the STDBY/RESET mode.

g. Install Ladder Driver No. 2 in its correct A4A11 position.

h. Exchange the positions of Ladder Driver No. 1 and No. 3 (A4A10 and A4A12).

i. Select the OPR mode and perform the adjustments in Table 4-7.

Table 4-7. LADDER ADJUSTMENT ②

| DECADE DIALS | ADJUSTMENT (A4A10) | VOLTMETER INDICATION (VDC) |
|---|---|---|
| 40.00000 | R6 LADDER ADJ 4 | 40V ± 40 uv |
| 80.00000 | R4 LADDER ADJ 8 | 80V ± 80 uv |
| 20.00000 | R8 LADDER ADJ 2 | 20V ± 20 uv |
| 10.00000 | R10 LADDER ADJ 1 | 10V ± 10 uv |
| 0X.00000 | R2 LADDER ADJ X10 | 10V ± 10 uv |

j. Select the STDBY/RESET mode and install the Ladder Driver No. 1 and No. 3 in their correct A4A10 and A4A12 positions.

k. Select the OPR mode.

l. Set the Decade Dials to 10.00000 and record the output voltage to within ±2 uv.

m. Set the Decade Dials to 0X.00000 and adjust A4A10R2, LADDER ADJ, X10, for the same voltage recorded in step 1.

### 4-53. Voltage Range Alignment

a. Set the Decade Dials to 10.00000.

b. Perform the adjustments in Table 4-8.

c. Select the STDBY/RESET mode and disconnect the voltmeter.

Table 4-8. VOLTAGE RANGE ADJUSTMENTS

| MODE (Range) | ADJUSTMENT (A4A17) | VOLTMETER INDICATION (VDC) |
|---|---|---|
| 10V | R15, 10V CAL | 10V ± 10 uv |
| 100V | R18, 100V CAL | 100V ± 0.1 mv |
| 1000V | R21, 1000V CAL | 1000V ± 1 mv |

## 4-54. MA Range Alignment

a. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .10000000 |

b. With the instrument in the OPR mode perform the adjustments in Table 4-9. Loads and voltmeter connections are made at the OUTPUT terminals using a four terminal shunt circuit connection.

c. Select the STDBY/RESET mode and disconnect the load and voltmeter.

## 4-55. Meter Alignment

a. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, OPR |
| METER READING | VOLTAGE |
| MODE | VOLTS, 1000 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 1000.0000 |

b. Adjust A4A4R5, METER ADJ. V, for a meter reading of 1000 ±10 vdc.

c. Check the meter reading at Decade Dial settings of 600.0000 and 200.0000. The meter reading should be within ±10 vdc of the selected output. If necessary, adjust A4A4R5, METER ADJ. V, for the best possible meter reading linearity.

d. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, OPR |
| METER READING | CURRENT |
| MODE | MA, 100 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | ON |
| Decade Dials | 100.00000 |

e. Adjust A4A4R2, METER ADJ. I, for a meter reading of 100 ±1 ma.

f. Select the STDBY/RESET and CROWBAR OFF modes.

## 4-56. Current Limit Alignment

4-57. Two methods can be used to align the CURRENT LIMIT feature; one is for manual front panel operation, and the other is for remote operation. Choice of either method depends on the particular instrument applications.

4-58. MANUAL CURRENT LIMIT ADJUSTMENTS. If the Model 3330B is to be operated manually, perform the following CURRENT LIMIT adjustments:

a. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, OPR |
| METER READING | CURRENT |
| MODE | MA, 100 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | ON |
| Decade Dials | 10X.X0000 |

Table 4-9. MA RANGE ADJUSTMENTS

| MODEL 3330B CONTROLS | | OUTPUT LOAD | VOLTMETER INDICATION (VDC) | ADJUSTMENT (A4A17) |
|---|---|---|---|---|
| MA RANGE | DECADE DIALS | | | |
| 1 | .10000000 | 1K, Std. | 1V ± 2 uv | R1, 1MA CAL |
| 10 | 10.000000 | 100Ω, Std. | 1V ± 2 uv | R5, 10 MA CAL |
| 100 | 100.00000 | 10Ω, Std. | 1V ± 2 uv | R9, 100MA CAL |

b. Adjust A4A7R23, HI CURRENT LIMIT ADJ, until the I LIMIT/V TRIP lamp just illuminates.

c. Set the Decade Dials to 01.00000.

d. Slide the CURRENT LIMIT vernier to LO and adjust A4A7R24, LO CURRENT LIMIT ADJ., until the I LIMIT/V TRIP lamp just illuminates.

e. Repeat steps a through d until the specified results are obtained.

f. Select the STDBY/RESET and CROWBAR OFF modes.

4-59. REMOTE CURRENT LIMIT ADJUSTMENT. If the Model 3330B is to be operated remotely, perform the following CURRENT LIMIT adjustments:

a. Program the following operating conditions:

| | |
|---|---|
| POWER | OPR |
| MODE | MA, 100 |
| V TRIP/I LIMIT | REMOTE |
| V TRIP/ RANGE | 100V |
| V TRIP VERNIER | 110% (8 + 2 + 1) |
| CURRENT LIMIT | 110% (8 + 2 + 1) |
| CROWBAR | ON |
| POLARITY | POSITIVE |
| Decades | 10X.XX000 |

b. Adjust A4A7R23, HIGH CURRENT LIMIT ADJ., until the I LIMIT/V TRIP lamp just illuminates.

c. Program the Decades to 01.00000 and the CURRENT LIMIT to LO (0-0-0-0).

d. Adjust A4A7R24, LO CURRENT LIMIT ADJ, until the I LIMIT/V TRIP lamp just illuminates.

e. Repeat steps a through d until the specified results are obtained.

f. Program the conditions in Table 4-10, observing that the I LIMIT/V TRIP lamp illuminates within the specified limit tolerance.

g. Program the STDBY/RESET and CROWBAR OFF conditions.

## 4-60. Voltage Trip Alignment

a. Rotate A4A4R13, V TRIPOUT ADJ, fully counter-clockwise.

Table 4-10. REMOTE CURRENT LIMIT CHECKS

| DECADES | CURRENT LIMIT | LIMIT TOLERANCE (MA) |
|---|---|---|
| 80.00000 | 80% (8) | 80 ± 10% |
| 40.00000 | 40% (4) | 40 ± 10% |
| 20.00000 | 20% (2) | 20 ± 20% |
| 10.00000 | 10% (1) | 10 ± 20% |

b. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 100 |
| VOLTAGE TRIP | 100, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 10X.XX000 |

c. Select the OPR mode and adjust A4A4R13 clockwise until the Model 3330B trips to the STDBY/reset mode. The I LIMIT/V TRIP lamp should illuminate, and the OPR lamp should go out.

d. Select the STDBY/RESET mode.

## 4-61. Final Calibration

4-62. The following calibration procedures should be done only after the Model 3330B has been operated for at least 24 hours at an ambient room temperature of 23°C ±1°C, with the output set to 100 volts on the 100 volt range. The inner cover must be installed and the top dust cover set in place during the operating period. All output measurements are done using a FLUKE model 7105A System or equivalent.

4-63. FINAL RANGE ZERO

a. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 0.000000 |

b. Connect a null detector (FLUKE 7105A System) to the OUTPUT terminals.

c. Select the OPR mode and perform the adjustments in Table 4-11

Table 4-11. FINAL RANGE ZERO ADJUSTMENTS

| VOLTAGE RANGE | ADJUSTMENT (A4A1) | NULL DETECTOR INDICATION |
|---|---|---|
| 10 | 10V ZERO ADJ | 0 ± 2 uv |
| 100 | 100V ZERO ADJ | 0 ± 20 uv |
| 1000 | 1 KV ZERO ADJ | 0 ± 200 uv |

d. Select the STDBY/RESET mode and disconnect the null detector.

4-64. FINAL LADDER AND VOLTAGE RANGE.

a. Connect a dc differential voltmeter (FLUKE 7105A System) to the OUTPUT terminals, observing proper polarity.

b. Select the 100 volt range and OPR mode.

c. Perform the adjustments in Table 4-12.

Table 4-12. FINAL LADDER ADJUSTMENTS

| DECADE DIALS | ADJUSTMENT (A4A10) | DVM INDICATION (VDC) |
|---|---|---|
| 40.00000 | 100V CAL (A4A17) | 40V ± 40 uv |
| 80.00000 | LADDER ADJ 8 | 80V ± 80 uv |
| 20.00000 | LADDER ADJ 2 | 20V ± 20 uv |
| 10.00000 | LADDER ADJ 1 | 10V ± 10 uv |
| 0X.00000 | LADDER ADJ X10 | 10V ± 10 uv |

d. Select the STDBY/RESET mode and then connect a power supply calibrator (FLUKE 7105A System) to the OUTPUT terminals.

e. Select the OPR mode and then perform the adjustments in Table 4-13.

f. Perform the checks in Table 4-14.

g. Select the STDBY/RESET mode and disconnect the test equipment.

4-65. FINAL MA RANGE

a. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | CURRENT |
| MODE | MA, 1 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | .10000000 |

b. Connect a dc differential voltmeter (FLUKE 7105A System) to the OUTPUT terminals.

Table 4-14. FINAL VOLTAGE RANGE CHECKS

| MODEL 3330B CONTROL SETTINGS | | POWER SUPPLY CALIB. INDICATION |
|---|---|---|
| RANGE | DECADE DIALS | (VDC) |
| 10 | 5.000000 | 5V ± 15 uv |
| 100 | 50.00000 | 50V ± 15 uv |
| 1000 | 500.0000 | 500V ± 15 uv |

c. With the Model 3330B in the OPR mode, perform the adjustments in Table 4-15. The specified load must be connected between the OUTPUT terminals and voltmeter using a four terminal shunt connection.

d. Select the STDBY/RESET mode and disconnect the test equipment. Calibration of the Model 3330B is completed. Table 4-16 contains a summary of all calibration steps.

Table 4-13. FINAL VOLTAGE RANGE ADJUSTMENTS

| MODEL 3330B CONTROL SETTINGS | | ADJUSTMENT (A4A17) | PWR. SUPPLY CALIB. INDICATION (VDC) |
|---|---|---|---|
| RANGE | DECADE DIALS | | |
| 10 | 10.000000 | 10V CAL | 10V ± 4 uv |
| 100 | 100.00000 | 100V CAL | 100V ± 4 uv |
| 1000 | 1000.0000 | 1000V CAL | 1000V ± 4 uv |

Table 4-15. FINAL MA RANGE ADJUSTMENTS

| MODEL 3330B CONTROL SETTINGS | | LOAD (Rstd) | ADJUSTMENT (A4A17) | DVM INDICATION (VDC) |
|---|---|---|---|---|
| MA RANGE | DECADE DIALS | | | |
| 1 | .10000000 | 1K | 1 MA CAL | 1V ± 1 uv |
| 10 | 10.000000 | 100Ω | 10 MA CAL | 1V ± 1 uv |
| 100 | 100.00000 | 10Ω | 100 MA CAL | 1V ± 1 uv |

Table 4-16. CALIBRATION PROCEDURE SUMMARY (Sheet 1 of 2)

| STEP | PARA | PROCEDURE | RESULT |
|---|---|---|---|
| 1 | 4-46 | Preliminary Calibration | (1 hr. warm-up, 10V Range-0.000000 OUTPUT) |
| 2 | 4-47 | ±25 and −5 VDC Alignment<br>+25V ADJ<br>−25V ADJ<br>− 5V ADJ | <br>+25 ±0.01 vdc (A4A8-10, + SENSE)<br>−25 ±0.025 vdc (A5A1-6, 5)<br>− 5 ±0.01 vdc (A5A1 - 16, 5) |
| 3 | 4-48 | Chopper Alignment<br>CHOPPER DRIVE ADJ<br>CHOPPER COMP ADJ<br>CHOPPER DRIVE ADJ<br><br>CHOPPER COMP ADJ | (Scope to A4A2Q3 base, + SENSE)<br>Fully cw<br>Minimum pulse amplitude<br>ccw for noise. cw for clean signal +1/8 turn cw.<br>Equal pulse amplitude |
| 4 | 4-49 | Current Ripple Compensation<br><br>A7R1 | (RMS Voltmeter at OUTPUT with 10K load)<br>Minimum rms voltage at OUTPUT |
| 5 | 4-50 | Range Zero Alignment<br>10V ZERO ADJ<br>100V ZERO ADJ<br>1000V ZERO ADJ | (DVM at OUTPUT)<br>0 ± 2 μv<br>0 ± 20 μv<br>0 ± 0.2 mv |
| 6 | 4-51 | 10 Volt Reference Alignment<br>REF ADJ | (DVM at TEST ±)<br>10V ±10 μv |
| 7 | 4-52 | Ladder Alignment (Decade Dials)<br>(1) Ladder 1<br>100V CAL (40.00000)<br>LADDER ADJ 8 (80.00000)<br>LADDER ADJ 2 (20.00000)<br>LADDER ADJ 1 (10.00000)<br>LADDER ADJ X10 (0X.00000)<br>(2) Swap Ladder 1 & 2<br>(3) Ladder 2<br>LADDER ADJ 4 (40.00000)<br>LADDER ADJ 8 (80.00000)<br>LADDER ADJ 2 (20.00000)<br>LADDER ADJ 1 (20.00000)<br>LADDER ADJ X10 (0X.00000) | (DVM at OUTPUT)<br><br>40v ± 40 μv<br>80v ± 80 μv<br>20v ± 20 μv<br>10v ± 10 μv<br>10v ± 10 μv<br><br><br>40v ± 40 μv<br>80v ± 80 μv<br>20v ± 20 μv<br>20v ± 10 μv<br>10v ± 10 μv |

Table 4-16. CALIBRATION PROCEDURE SUMMARY (Sheet 2 of 2)

| STEP | PARA | PROCEDURE | RESULT |
|---|---|---|---|
| 7 | 4-52<br>Cont. | (4) Return Ladder 2<br>(5) Swap Ladder 1 & 3<br>(6) Repeat step (3)<br>(7) Return Ladder 1 & 3<br>(8) Decade Dials to 10.00000<br>(9) Decade Dials to 0X.00000<br>(10) LADDER ADJ X10 | Record Output (± 2 μv)<br>Step (8) Voltage Level |
| 8 | 4-53 | Voltage Range Alignment<br>10V CAL (10.000000)<br>100V CAL (100.00000)<br>1000V CAL (1000.0000) | (DVM at OUTPUT)<br>10V ±10 μv (10V Range)<br>100V ± 0.1 mv (100V Range)<br>1000V ± 1 mv (1000V Range) |
| 9 | 4-54 | MA Range Alignment<br>1 MA CAL (1.000000)<br>10 MA CAL (10.00000)<br>100 MA CAL (100.0000) | (DVM and Load at OUTPUT)<br>1v ± 2 μv, 1k Std. (1 MA Range)<br>1v ± 2 μv, 100Ω Std. (10 MA Range)<br>1v ± 2 μv, 10Ω Std. (100 MA Range) |
| 10 | 4-55 | Meter Alignment<br>METER ADJ V<br>METER ADJ I (100.0000) | (Panel Meter Reading)<br>1000 ±10 vdc (1000v Range)<br>100 ±1 ma (100 MA Range) |
| 11 | 4-56<br>4-58<br><br><br>4-59 | Current Limit Alignment<br>MANUAL CURRENT LIMIT<br>HI CURRENT LIMIT (10X.X0000)<br>LO CURRENT LIMIT (01.00000)<br>REMOTE CURRENT LIMIT<br>HI CURRENT LIMIT (10X.X0000)<br>LO CURRENT LIMIT (01.00000) | (100 MA Range, CROWBAR ON)<br><br>I LIMIT/V TRIP Indication (CURRENT LIMIT HI)<br>I LIMIT/V TRIP Indication (CURRENT LIMIT LO)<br><br>I LIMIT/V TRIP Indication (CURRENT LIMIT 110%)<br>I LIMIT/V TRIP Indication (CURRENT LIMIT <1%) |
| 12 | 4-60 | Voltage Trip Alignment<br>VOLTAGE TRIP ADJ (10X.XX000) | (100V Range)<br>I LIMIT/V TRIP Indiction (VOLTAGE TRIP - 100, VERNIER HI) |
| 13 | 4-61 | Final Calibration | (24 hour Operation at 100V OUTPUT) |
| 14 | 4-63 | FINAL RANGE ZERO<br>10V ZERO ADJ (0.000000)<br>100V ZERO ADJ (00.00000)<br>1 kV ZERO ADJ (000.0000) | (Null Detector at OUTPUT)<br>0 ± 2 μv (10V Range)<br>0 ± 20 μv (100V Range)<br>0 ± 200 μv (1000V Range) |
| 15 | 4-64 | FINAL LADDER AND VOLTAGE RANGE<br>100V CAL (40.00000)<br>LADDER ADJ 8 (80.00000)<br>LADDER ADJ 2 (20.00000)<br>LADDER ADJ 1 (10.00000)<br>LADDER ADJ X10 (0X.00000)<br>10V CAL (10.000000)<br>100V CAL (100.00000)<br>1000V CAL (1000.0000) | (DVM at OUTPUT — FLUKE 7105A)<br>40v ± 40 μv<br>80v ± 80 μv<br>20v ± 20 μv<br>10v ± 10 μv<br>10v ± 10 μv<br>10v ± 4 μv<br>100v ± 4 μv<br>1000V ± 4 μv |
| 16 | 4-65 | Final MA Range<br>1 MA CAL (.10 000000)<br>10 MA CAL (10.000000)<br>100 MA CAL (100.00000) | (DVM & LOAD at OUTPUT - FLUKE 7105A)<br>1v ± 1 μv, 1k Std. 1 MA Range<br>1V ± 1 μv, 100Ω Std. 10 MA Range<br>1V ± 1 μv, 10Ω Std, 100 MA Range |

## 4-66. TROUBLESHOOTING

### 4-67. Introduction

4-68. The following paragraphs present a general method of locating the cause of a malfunction. However, before any of these procedures are undertaken, it should be determined that the following conditions do exist:

a. The instrument is being operated properly.

b. It does not require calibration.

c. The plug-in circuit boards are properly seated.

d. An inspection has been made for loose wires, physically damaged components, or other obvious problems.

### 4-69. Major Circuit Isolation

4-70. The circuitry in the Model 3330B is composed of four major sections:

a. Auxiliary dc supplies.

b. Pre-regulator.

c. Main regulator.

d. Control circuitry

4-71. Isolation of a trouble in the dc supplies can be done using the information in Table 4-17. Problems in the preregulator or main regulator can be located using the information in paragraph 4-72. Control circuitry problems can be isolated using the information in paragraph 4-73.

**WARNING!**

**Avoid contact with the inner chassis and exposed parts. This circuitry is at the same potential as the +OUTPUT terminal. Also avoid contact with the Pre-regulator circuitry as it is at line power above ground. Always turn off the Model 3330B and wait a few seconds before removing any plug-in assemblies.**

4-72. REGULATOR LOOP ISOLATION. The basic circuitry of the Model 3330B consists of two interacting loops: The Pre-regulator and the Main Regulator. Consequently, problems in one loop can affect the operation of the other. Isolation of a trouble to the appropriate loop can be done in the following manner:

a. Turn off the Model 3330B

b. Remove the A5A2 Pre-regulator.

c. Connect the output of a general purpose power supply to the Model 3330B circuitry (+lead to the collector of Q1 in the A4A5 Series Pass and the –lead to the –OUTPUT terminal).

d. Set the power supply output to 70 volts above the selected output voltage of the Model 3330B. For example, if the output of the Model 3330B is set to 20.00000, the power supply output should be 90 vdc.

Table 4-17. AUXILIARY DC SUPPLY CHECKS

| TITLE | DESIGNATION | MEASUREMENT POINTS (+) | (–) | VOLTAGE |
|---|---|---|---|---|
| Sink Supply | HVPS (A4A6) | Pin 11 | + SENSE | +700 ±30 vdc |
| ±35V | CURRENT LIMITER (A4A7) | Pin 1<br>Pin 3 | + SENSE<br>+ SENSE | –36 ±3 vdc<br>+ 36 ±3 vdc |
| +25 –15V | +25 –15V PWR. SUPPLY (A4A8) | Pin 9<br>Pin 10 | + SENSE<br>+ SENSE | –15 ±1 vdc<br>+ 25 ±2 vdc |
| –25 –5V | –25 –5V PWR SUPPLY (A5A1) | Pin 6<br>Pin 16 | Pin 5<br>Pin 5 | –25 ±3 vdc<br>–5 ±1 vdc |
| ±V | PREREGULATOR (A5A2) | Pin 15<br>R17<br>C4 (+) | Pin 13<br>Pin 13<br>Pin 13 | –14V peak<br>+ 14V peak<br>+ 13 ±1 vdc |
| +130<br>6.8V | SERIES PASS (A4A5) | Q8 (c)<br>CR6 | + SENSE<br>+ SENSE | +130 ±10 vdc (STDBY/RESET)<br>+6.8 ±0.7 vdc |

e. Turn on the Model 3330B and select the OPR mode.

**FAULT ANALYSIS**

**If the selected output of the Model 3330B is present, the problem is in the Pre-regulator loop. Should an incorrect output be observed, the problem is in the Main Regulator loop.**

4-73. CONTROL CIRCUITRY. Correct operation of the control circuitry can be verified by checking for proper response of all front panel controls. Remote programming can be checked in essentially the same manner using the information in Section II. Problems in relay drivers will normally appear in both local or remote operation. Incorrect relay operation can cause problems in other sections of the instrument. This presents added troubleshooting dimensions that should be taken into consideration.

## 4-74. Preregulator Troubleshooting

4-75. Once a problem has been isolated to the Pre-regulator circuitry, the source of trouble can be located using the following procedure:

a. Turn off the Model 3330B.

b. Remove the A5A2 Pre-regulator.

c. Install the A4A5 Series Pass in the extender card.

d. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON, STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS 100 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 50.00000 |

**WARNING!**

**In performing step e use an ungrounded oscilloscope. This assures that the scope chassis and thus the LOW input is not connected to the high potential side of the power line.**

e. Connect the high input of an ungrounded oscilloscope to A4A5 terminal 15 and the low input to terminal 14.

**FAULT ANALYSIS**

**There should be positive pulses having an amplitude of 1 to 2 volts peak-to-peak present on the oscilloscope display (sweep speed set to 1 msec/cm). If the pulses are not observed, the problem is in the VCO circuitry in the A4A5 Series Pass.**

f. Turn off the Model 3330B and install the A4A5 Series Pass.

g. Install the A5A2 Pre-regulator on the extender card.

h. Connect the input of the oscilloscope to the base of A5A2Q1 and its common to the emitter.

i. Turn on the Model 3330B and select the STDBY/RESET mode.

**FAULT ANALYSIS**

**Positive going pulse trains having an amplitude of 1 to 2 volts peak-to-peak should be observed on the oscilloscope display. Intervals between pulse trains should be approximately 8 msec. If the pulse trains are not observed, the problem is in the A5A2 Pre-regulator.**

## 4-76. Main Regulator Troubleshooting

4-77. Once a problem is isolated to the Main Regulator it must be then further isolated to one of four sections which comprise this loop. These sections are as follows:

a. High Voltage

b. $E_{REF}$ and Ladder

c. Series Pass

d. Amplifier

4-78. HIGH VOLTAGE. The High Voltage can be checked by the substitution method given in paragraph 4-72 and the Preregulator checks given in 4-74. If these circuits are functioning normally, the problem is in the A4A6 H.V.P.S.

Table 4-18. SERIES PASS VOLTAGE CHECKS

| MODE | DECADE DIALS | OUTPUT LOAD (MA) | LINE VOLTAGE (VAC) | CHECK POINT (A4A5) | CHECK POINT VOLTAGE |
|---|---|---|---|---|---|
| VOLTS, 10 | 10.000000 | 110 | 100 | Q1 thru Q7 (Emitter to Collector) | Less than 4 vdc |
| VOLTS, 10 | 0.000000 | 0 | 130 | Q8 (Emitter to Collector) | 60 to 80 vdc |
| VOLTS, 1000 | 1000.0000 | 100 | 100 | Q8 (Emitter to Collector) | 15 to 25 vdc |

4-79. $E_{REF}$ AND LADDER. $E_{REF}$ can be checked with a dc voltmeter at the ± TEST points on the A4A1 +10V Reference Supply. The voltage at this point should be 10V ±10uv. The Ladders (A4A10 through A4A16) can be checked by connecting the dc voltmeter to the OUTPUT terminals and rotating the Decade Dials through each setting, observing for proper output stepping.

4-80. SERIES PASS. The A4A5 Series Pass regulation capability can be checked by measuring the voltage across the series pass transistors. However, this must be done under certain conditions given in Table 4-18.

4-81. AMPLIFIER. The action of the Amplifier, which is a combined function of the A4A3 Differential Amplifier, A4A2 Chopper Amplifier, and A4A4 Series Pass Driver, can be checked by monitoring the VCO pulses in the A4A5 Series Pass. To perform this check, proceed as follows:

a. Turn off the Model 3330B and remove the A5A2 Pre-regulator.

b. Connect a general purpose power supply to the OUTPUT terminals, observing proper polarity. Set the power supply output to 5.5 vdc.

c. Connect the input of an ungrounded oscilloscope to A4A5 terminal 15 and its common to 14.

d. Set the Model 3330B controls as follows:

| | |
|---|---|
| POWER | PUSH ON STBY/RESET |
| METER READING | VOLTAGE |
| MODE | VOLTS, 10 |
| VOLTAGE TRIP | 1000, VERNIER HI |
| CURRENT LIMIT | HI |
| CROWBAR | OFF |
| Decade Dials | 5.000000 |

e. Positive VCO pulses having an amplitude of 1 to 2 volts peak-to-peak should be present on the oscilloscope display (sweep speed set to 1 msec/cm).

f. Set the Decade Dials to 6.000000. The VCO pulse should disappear.

**FAULT ANALYSIS**

**If the VCO pulses are present with the Decade Dials set to 6.000000, the problem is in the Amplifier section. General troubleshooting of the associated circuitry should then reveal the source of trouble. Additional checks are given in Table 4-19.**

Table 4-19. RANGE CIRCUITRY CHECKS

| MODE | DECADE DIALS | VCO PULSES |
|---|---|---|
| VOLTS, 100 | 05.00000 | Present |
| VOLTS, 100 | 06.00000 | Not Present |
| VOLTS, 1000 | 005.0000 | Present |
| VOLTS, 1000 | 006.0000 | Not Present |

Section 5

# Lists of Replaceable Parts

## 5-1. INTRODUCTION

5-2. This section of the manual is a complete illustrated parts list breakdown itemizing all assemblies and their components for this instrument. Illustrations with each listing aid in locating the assemblies and components. A Cross Reference List of Fluke stock numbers to original manufacturers' part numbers is included at the rear of this section.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A, followed by a number (e.g., A1 etc.). Electrical components appearing on the schematic diagram are identified by their reference designation. Components not appearing on the schematic diagram are identified by Fluke stock numbers on the illustrations. Flagnotes are sometimes used and refer to special ordering explanations.

## 5-4. PARTS LIST COLUMN DESCRIPTIONS

a. The REF DESIG column indexes the item description to the associated illustration. In general, the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.

b. The DESCRIPTION column describes the salient characteristics of the component. Idention of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, refer to Appendix B located at the rear of the manual.

c. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

d. The TOT QTY column lists the total quantity of the items used and reflects the latest Use Code. Second and subsequent listings of the same items are referenced to the first listing with the abbreviation REF. The TOT QTY column lists the total quantity of the item in that particular assembly.

e. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of every part in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

f. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number by consulting the Serial Number Effectivity List, paragraph 5-9. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

## 5-5. MANUFACTURERS' CROSS REFERENCE LIST COLUMN DESCRIPTIONS

a. The six-digit part number, by which the item is identified at the John Fluke Mfg. Co., Inc. is listed in the FLUKE STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.

b. The Federal Supply Code for the item manufacturer is listed in the MFG column. An abbreviated list of Federal Supply Codes is included in Section 7.

c. The part number which uniquely identifies the item to the original manufacturer is listed in the MFG. PART NO. column. If a component must be ordered by description, the type number is listed.

## 5-6. HOW TO OBTAIN PARTS

5-7. Standard components have been used wherever possible. These components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the Fluke part number. In the event the part you order from Fluke has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-8. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co., Inc. if you include the following information:

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation.

e. Instrument model and serial number.

Example: 2 each 266015, Transistor, 2N5138, A3Q4 & Q5 for 3330B S/N 193.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location to other parts of the instrument, is usually most helpful.

## 5-9. SERIAL NUMBER EFFECTIVITY

5-10. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 3330B. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used in all instruments with serial numbers above 193.

| USE CODE | EFFECTIVITY |
|---|---|
| NONE | Model 3330B serial number 193 and on. |
| A | SN 193 thru 202 |
| B | SN 203 and on |
| C | SN 193 thru 252 |
| D | SN 253 and on |

| REF DESIG | DESCRIPTION | STOCK NO | TOT QTY | REC QTY | USE CODE |
|---|---|---|---|---|---|
| | **PROGRAMMABLE VOLTAGE/CURRENT CALIBRATOR** **Figure 5-1** | 3330B | | | |
| A1 | Front Panel Assembly (See Figure 5-2) | | 1 | | |
| A2 | Rear Panel Assembly (See Figure 5-1) | | 1 | | |
| A3 | Front Mother Board Assembly (3330B-4006) (See Figure 5-3) | 286310 | 1 | | |
| A3A1 | Decade Switch Assembly (333A-4019) (See Figure 5-4) | 262790 | 1 | | |
| A3A2 | Switch Board Assembly (3330B-4007) (See Figure 5-5) | 288068 | 1 | | |
| A3A3 | I/V Limit Vernier Assembly (333A-4012) (See Figure 5-6) | 251991 | 1 | | |
| A4 | Main Mother Board Assembly (3330B-4001) (See Figure 5-7) | 285460 | 1 | | |
| A4A1 | +10 Volt Reference Supply Assembly (333A-4005) (See Figure 5-8) | 251926 | 1 | | |
| A4A2 | Chopper Amplifier Assembly (333A-1004) (See Figure 5-9) | 251918 | 1 | | |
| A4A3 | Differential Amplifier Assembly (3330B-4003) (See Figure 5-10) | 285569 | 1 | | |
| A4A4 | Series Pass Driver Assembly (333A-4024) (See Figure 5-11) | 275388 | 1 | | |
| A4A5 | Series Pass Element Assembly (333A-4034) (See Figure 5-12) | 283465 | 1 | | |
| A4A6 | High Voltage Power Supply Assembly (3330B-4002) (See Figure 5-13) | 285478 | 1 | | |
| A4A7 | Current Limiter Assembly (333A-4032) (See Figure 5-14) | 282848 | 1 | | |
| A4A8 | +25 & −15 Volt Power Supply Assembly (335A-4059) (See Figure 5-15) | 219188 | 1 | | |
| A4A9 | Relay Driver Assembly (333A-4009) (See Figure 5-16) | 251967 | 1 | | |
| A4A10 | Ladder Driver No. 1 Assembly (3330B-4031) (See Figure 5-17) | 405476 | 1 | | |
| A4A11 | Ladder Driver No. 2 Assembly (333A-4029) (See Figure 5-18) | 275420 | 1 | | |
| A4A12 | Ladder Driver No. 3 Assembly (333A-4028) (See Figure 5-18) | 275412 | 1 | | |

| REF DESIG | DESCRIPTION | STOCK NO | TOT QTY | REC QTY | USE CODE |
|---|---|---|---|---|---|
| A4A13 | Ladder Driver No. 4 Assembly (333A-4016) (See Figure 5-19) | 252031 | 1 | | |
| A4A14 | Ladder Driver No. 5 Assembly (333A-4002) (See Figure 5-20) | 251892 | 3 | | |
| A4A15 | Ladder Driver No. 6 Assembly (333A-4002) (See Figure 5-20) | 251892 | REF | | |
| A4A16 | Ladder Driver No. 7 Assembly (333A-4002) (See Figure 5-20) | 251892 | REF | | |
| A4A17 | Range Shunt Network Assembly (333A-4008) (See Figure 5-21) | 251959 | 1 | | |
| A5 | Rear Mother Board Assembly (3330B-4005) (See Figure 5-22) | 286013 | 1 | | |
| A5A1 | –25 & –5 Volt Power Supply Assembly (333A-4003) (See Figure 5-23) | 251900 | 1 | | |
| A5A2 | Preregulator Assembly (335A-4082) (See Figure 5-24) | 222000 | 1 | | |
| A6 | Relay Board Assembly (3330B-4004) (See Figure 5-25) | 286195 | 1 | | |
| A7 | Inner Chassis Assembly (See Figure 5-1) | | 1 | | |
| | Extender Card PCB | 187344 | 1 | | |
| | Card puller ring | 170951 | 1 | | |
| | Connector, male, 50 contact (mates with J8) | 266056 | 1 | | |
| | Cover, bottom | 287177 | 1 | | |
| | Cover, top | 287169 | 1 | | |
| | Foot | 230037 | 4 | | |
| | Line cord | 226100 | 1 | | |
| | Rack mounting kit | 243279 | 1 | | |
| | Tilt stand | 231407 | 1 | | |