# INSTRUCTION MANUAL

## RBX SERIES

## POWER SUPPLY

### SINGLE OUTPUT SWITCHING POWER SUPPLY

KEPCO INC.
An ISO 9001 Company.

CE

**MODEL**
**RBX SERIES**
**POWER SUPPLY**

| ORDER NO. | REV. NO |
|---|---|
| | |

NOTE: This on-line version of the Technical Manual includes only installation and operating instructions. For the complete manual, please contact Kepco.



KEPCO®
THE POWER SUPPLIER™

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# SECTION I—INTRODUCTION

## 1-1 SCOPE OF MANUAL

1-2 This manual contains specifications, information for the installation and operation, as well as troubleshooting notes and service documentation for the Kepco RBX Series of switching power supplies.

## 1-3 DESCRIPTION (Refer to FIG. 1-1).

1-4 The Kepco RBX Series consists of several single output switching power supplies, rated as listed in paragraph 1-7. The RBX power supply is a compact, high efficiency design, producing its d-c output while operating from either 115V a-c nominal or 230V a-c power lines (Selectable, See Section II of this Manual).

The output power stage of the RBX uses FET transistors in a half-bridge circuit configuration, operating at a switching frequency of approximately 150 KHz.

1-5 The output voltage of the RBX may be adjusted either locally or remotely, over the range of −20% to +10% of the rated nominal output. Remote, optically isolated turn-on/off is provided. Remote error sensing (0.35 V per load wire) may be performed at the load to eliminate load wire voltage drops.

1-6 Protective features include a dual current limiting system, over/undervoltage protection, driver inhibit and a fan sensing circuit which shuts off the power supply on fan failure. A balancing circuit permits paralleling of up to three RBX power supplies of equal output current ratings with only 10% derating on each output.

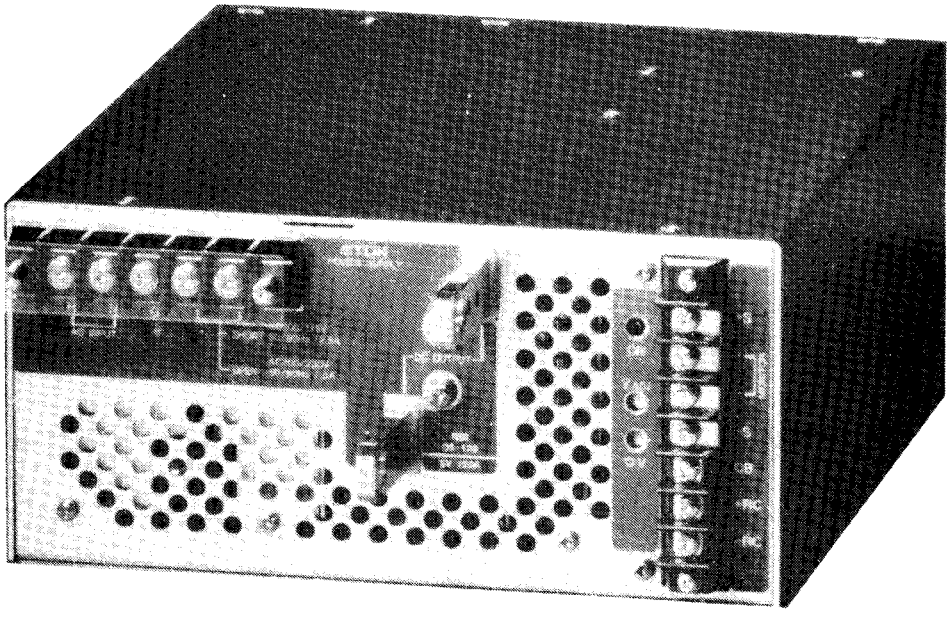


FIG. 1-1 SERIES RBX SWITCHING POWER SUPPLY, TYPICAL REAR VIEW.

## 1-7 SPECIFICATIONS, ELECTRICAL

| Parameter | | RBX 02-120K | RBX 05-120K | RBX 12-50K | RBX 24-25K | RBX 48-12.5K |
|---|---|---|---|---|---|---|
| **a-c Input Voltage** | 115/230V Selectable (85-132/170-264) | | | | | |
| **a-c Brown-out Voltage** | 80/160V a-c | | | | | |
| **a-c Input Frequency** | 47-440Hz | | | | | |
| **Output Voltage** | | 2V | 5V | 12V | 24V | 48V |
| **Output Adj. Range** | | 1.6 ~ 2.2V | 4.0 ~ 5.5V | 9.6 ~ 13.2V | 19.0 ~ 26.5V | 38.4 ~ 52.8V |
| **Output Current** | | 0-120A | 0-120A | 0-50A | 0-25A | 0-12.5A |
| **Overvoltage Setting** | | 2.6 ~ 2.8V | 6.0 ~ 6.5V | 14.0 ~ 14.5V | 27.0 ~ 27.5V | 55.0 ~ 57.0V |
| **Overcurrent Setting** | | 125 ~ 145A | 125 ~ 145A | 52 ~ 60A | 26 ~ 30A | 13 ~ 15A |
| **Max. a-c Input Current at Nominal Output Power** | At Minimum Input Voltage | 8/4.5A | 13.5/8A | 13.5/8A | 13/8A | 13/8A |
| **First ½-Cycle Surge Peak Current at Turn-on** | 115V a-c: 15A/230V a-c: 30A | | | | | |
| **Efficiency** | | 65% | 80% | 80% | 85% | 85% |
| **Hold-up Time:** (nom. input, full load) | 30 msec typically, 20 msec minimum | | | | | |
| **Output Power** | | 240 Watts | 600 Watts | 600 Watts | 600 Watts | 600 Watts |
| **Source Effect:** (min — max) | typ | 1.5% | 0.8% | 0.8% | 0.6% | 0.6% |
| | max | 3.0% | 1.6% | 1.6% | 1.2% | 1.2% |
| **Load Effect:** (10% — 100%) | typ | 1.0% | 0.4% | 0.4% | 0.3% | 0.3% |
| | max | 2.0% | 0.8% | 0.8% | 0.6% | 0.6% |
| **Temperature Effect:** (0°C — 50°C) | typ | | | 0.2% | | |
| | max | | | 1.0% | | |
| **Combined Effect:** | typ | 2.7% | 1.4% | 1.4% | 1.1% | 1.1% |
| | max | 4.0% | 2.0% | 2.0% | 2.0% | 2.0% |
| **Ripple & Noise:** (source & switching components, p-p) | typ | <10mV | <20mV | <25mV | <25mV | <50mV |
| | max | <50mV | <100mV | <100mV | <100mV | <200mV |
| **Spike Noise:** (d-c to 50 MHz, p-p) | max | <100mV | <200mV | <250mV | <250mV | <500mV |
| **Time Effect:** (0.5-8 hr. drift at 25°C, maximum load) | typ | 0.1% | | | | |
| | max | 0.5% | | | | |
| **Recovery Characteristics:** 50-100% Load Change Step rise or fall >50μsec | Excursion | <10% | <4.0% | <4.0% | <4.0% | <4.0% |
| | Recovery to 1% of Setting | 300 μsec. | 300 μsec. | 300 μsec. | 300 μsec. | 300 μsec. |

## 1-8 ENVIRONMENTAL AND MECHANICAL SPECIFICATIONS:

| | | |
|---|---|---|
| **Operating Temperature-Range** | Mounting horizontally using the provided mounting holes | 0°C to +50°C ambient |
| **Storage Temperature-Range** | N.A. | −25°C to +75°C |
| **Humidity:** | Operating or Non-operating Non-Condensing | Up to 85% RH |
| **Vibration:** | 5-10 Hz.<br>10-55 Hz. | 10 mm, 3 axes<br>2g, 3 axes |
| **Shock:**<br>**Size** | 11 ms ± 5 ms.<br>N.A. | 20 g, 3 axes<br>See FIG. 1-2 |
| **Weight** | N.A. | See FIG. 1-2 |
| **Safety** | N.A. | UL 478 recognized; CSA C22.2-154, certified |
| **Isolation**<br>@ 20°C, 65% RH. | Between input and output terminals<br>Between input terminals and chassis<br>Between ground and output terminals<br>Between ±RC terminals and output | 2KV a-c for 1minute (without Y capacitor)<br>2KV a-c for 1 minute<br>500V, 50 Megohm minimum<br>500V d-c, 50 Megohm minimum |
| **Warranty** | Operated within given specifications | 5 years |

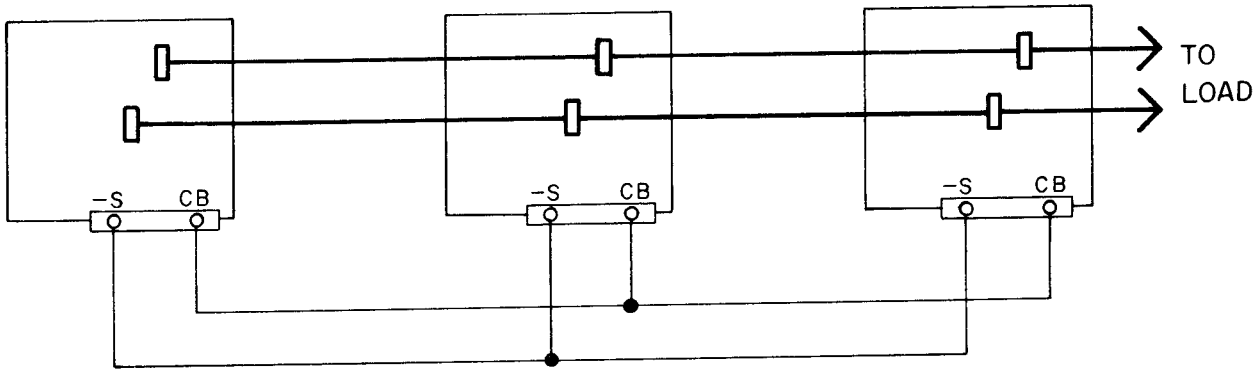
## 1-9 SPECIFICATIONS, ACCESSORY FUNCTIONS

A) REMOTE ERROR SENSING. Remote error sensing can compensate for load wire voltage drops up to 0.35V per wire.

B) REMOTE ON/OFF. A TTL compatible logic level signal, applied to the ±RC terminals may be used to turn the power supply output "on" or "off". This signal is optically isolated from the output terminals.

OUTPUT ON: "H" LEVEL: +2.4V to 24V (or ±RC open)
OUTPUT OFF: "L" LEVEL: 0V to +0.4V (or ±RC shorted)

C) BALANCE CIRCUIT. Up to three (3) RBX power supplies, with identical output ratings, may be paralleled by connecting their "CB" and "-S" terminal as shown below.




***NOTES:*** *1) Maximum units in parallel: three (3)*
*2) Output voltages of parallel units must be within 5% of each other.*
*3) Output current range of each unit 20-95% at nominal line.*

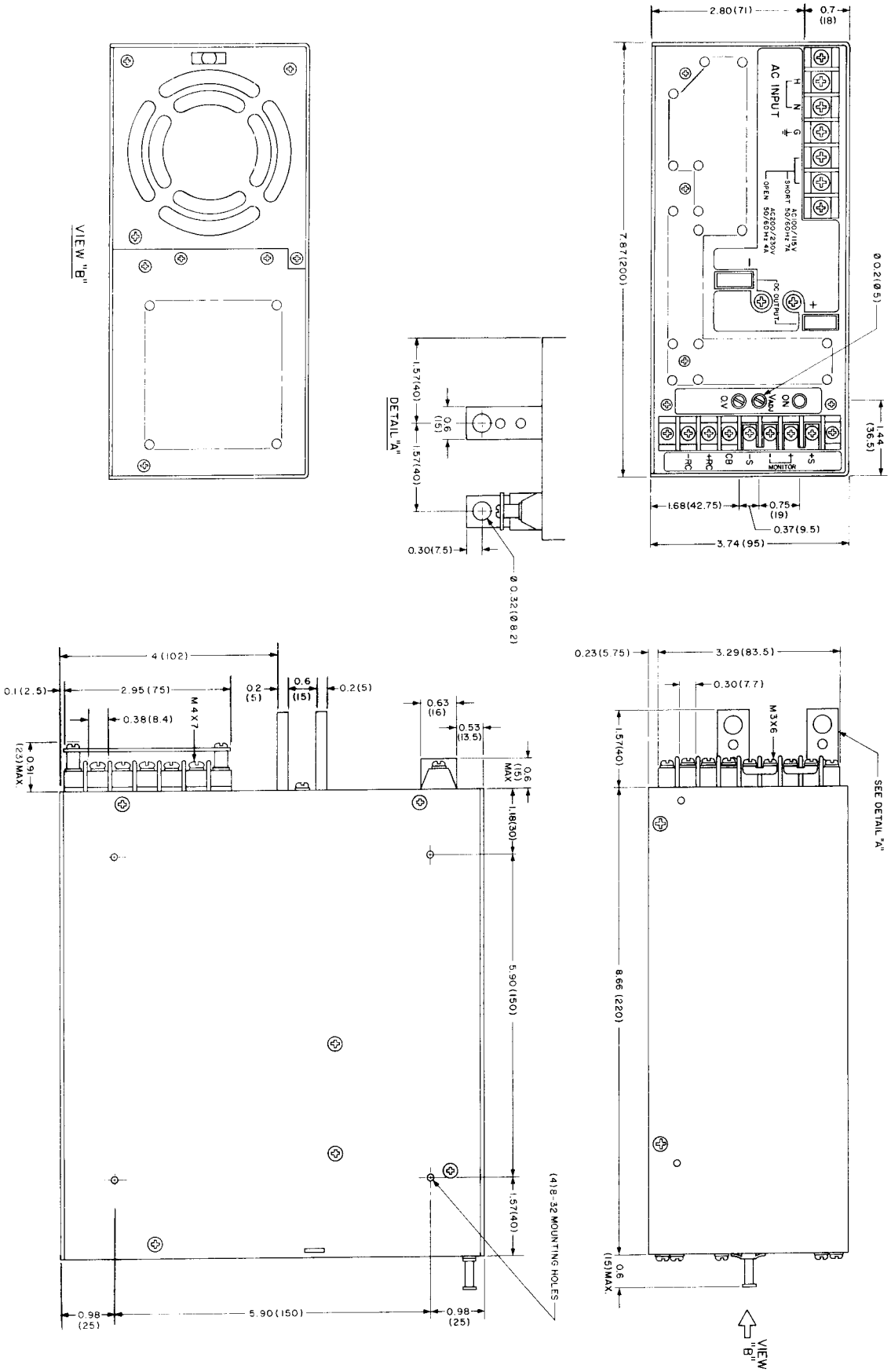



FIG. 1-2 MECHANICAL OUTLINE DRAWING, RBX SERIES, WITH COVER.

NOTES:

1) Dimensions in parentheses are in millimeters, others are in inches.
2) TOLERANCES: 0.04" (1 mm) unless otherwise noted.
3) TERMINAL SCREWS: M3 x 6 and M4 x 7 as indicated.
4) MOUNTING SCREWS: (4) 8-32 machine screws, maximum penetration: 0.2" (5 mm).
5) MATERIAL AND FINISH: Chassis and Cover: Aluminium, cadmium plated.
6) WEIGHT: 9.25 lbs. (4.2 Kg.) 5V, 12V, 24V and 48V models; 8.6 lbs. (3.9 Kg.) 2V model.

# SECTION II—INSTALLATION

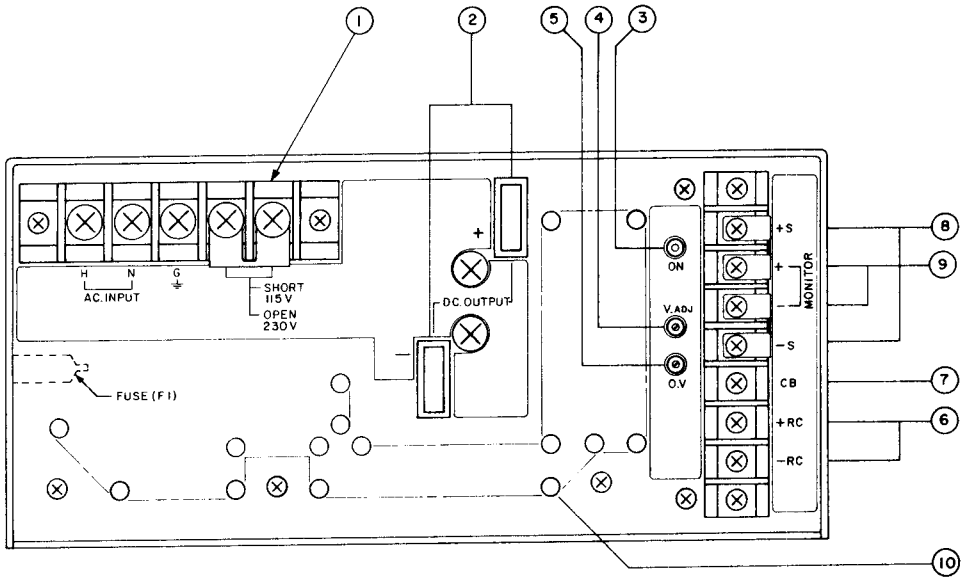
## 2-1 UNPACKING AND INSPECTION

2-2 This instrument has been inspected and tested prior to packing and is ready for operation. Unpack carefully and RETAIN THE ORIGINAL PACKING MATERIAL. Remove the instrument cover (Refer to SECTION V, FIG. 5-1) and inspect the interior of the instrument for possible physical damage sustained during shipping. If any such damage is found, notify the responsible transport service or carrier. Notify the nearest Kepco Sales Organization. Replace instrument cover and perform the preliminary check outlined in par. 2-15.

## 2-3 REPACKING FOR SHIPMENT

2-4 If the RBX power supply must be shipped or transported, repack with the original packing material.

2-5 **TERMINATIONS:** Refer to FIG. 2-1




1) a-c input terminals with ground and line voltage selector terminals.
2) Heavy duty d-c output terminals.
3) d-c output "on" LED lamp.
4) Output voltage adjustment.
5) Overvoltage limit adjustment.
6) Remote "On-Off" terminals (± RC)
7) Sync terminals for parallel connections (CB).
8) Remote sensing terminals (± S)
9) Output monitor terminals
10) Ventilation holes.

FIG. 2-1 TERMINATIONS REAR, RBX SERIES POWER SUPPLY.

## 2-6 SOURCE POWER REQUIREMENTS

2-7 The RBX power supply may be operated from 115V a-c nominal (85-132V a-c) **or** from 230V a-c nominal (170-264V a-c), 50 or 60 Hz nominal (47-440 Hz), single phase power lines. The power supply is normally delivered for service on 115V a-c lines and can be reconfigured for 230V a-c service by removing the jumper shown on FIG. 2-1, item (1). Maximum a-c input current at nominal output power for the RBX Series is given in paragraph 1-7.

2-8 All input current values are given in amperes, rms. Switching power supplies, however, take their source currents in pulse form from the a-c source and do not look kindly upon "soft-line" conditions. For this reason it is advisable to design the a-c input circuit generously, that is, for at least twice the required rms current.

2-9 FUSE CHANGE. The a-c input fuse (F1) is accessible after cover removal (Refer to Sect. V, FIG. 5-1), on the left side of the unit as seen from the terminal end. Fuses are time-delay type, BUSS MDA20 (Kepco P/N 541-0082) for Models RBX 05-120K thru RBX 48-12.5K and BUSS MDA15 (Kepco P/N 541-0026) for Model RBX 02-120K. The internal thermal fuse (F2) protects the turn-on resistors (R2, R3, R9) and is directly attached to R9. For replacement, use UCHIHASHI Type 014 or Kepco P/N 541-0081.

## 2-10 PRELIMINARY ELECTRICAL CHECK (Refer to FIG. 2-1)

2-11 Following the mechanical inspection described in paragraph 2-1, an electrical check may be performed by connecting the RBX power supply to the a-c input source and monitoring the output voltage across the (±) DC OUTPUT terminals. See Section V for more extensive output measurements.

## 2-12 INSTALLATION (Refer to the MECHANICAL OUTLINE DRAWING, Sect. I, FIG. 1-2)

2-13 The RBX power supply may be mounted and operated in any position. Four (4) mounting holes are provided on the chassis bottom. If the unit is installed without resting on its bottom surface, additional mounting support in the form of brackets or the like may be required.

2-14 The RBX power supply is fan-cooled and must be installed with sufficient space in both directions of the airflow. The ambient temperature, as measured at the fan intake, must not exceed 50°C.

## 2-15 GROUNDING

2-16 A-C GROUND. For safety and functional reasons, this power supply must be operated with its ground terminal ("G") returned to a-c ground. If the RBX power supply is mounted to a non-grounded surface and a 3-wire line cord is used and connected to a grounded a-c line, this is accomplished automatically. Grounding can also be achieved by mounting the unit with its metal chassis onto a grounded metal surface.

2-17 D-C GROUND. "Ripple and Noise" specifications (See Section I, paragraph 1-7) are valid only with the "common" (-S) terminal returned to ground as shown in the diagrams of Section III.

# SECTION III—OPERATION

## 3-1 LOAD CONNECTIONS

3-2 Load connections to a single RBX power supply are illustrated in FIG. 3-1. The load is connected to the heavy-duty D-C OUTPUT bars. For most applications, remote error sensing is used as shown, to compensate for the voltage drop in the load-connecting wires or bus bars.

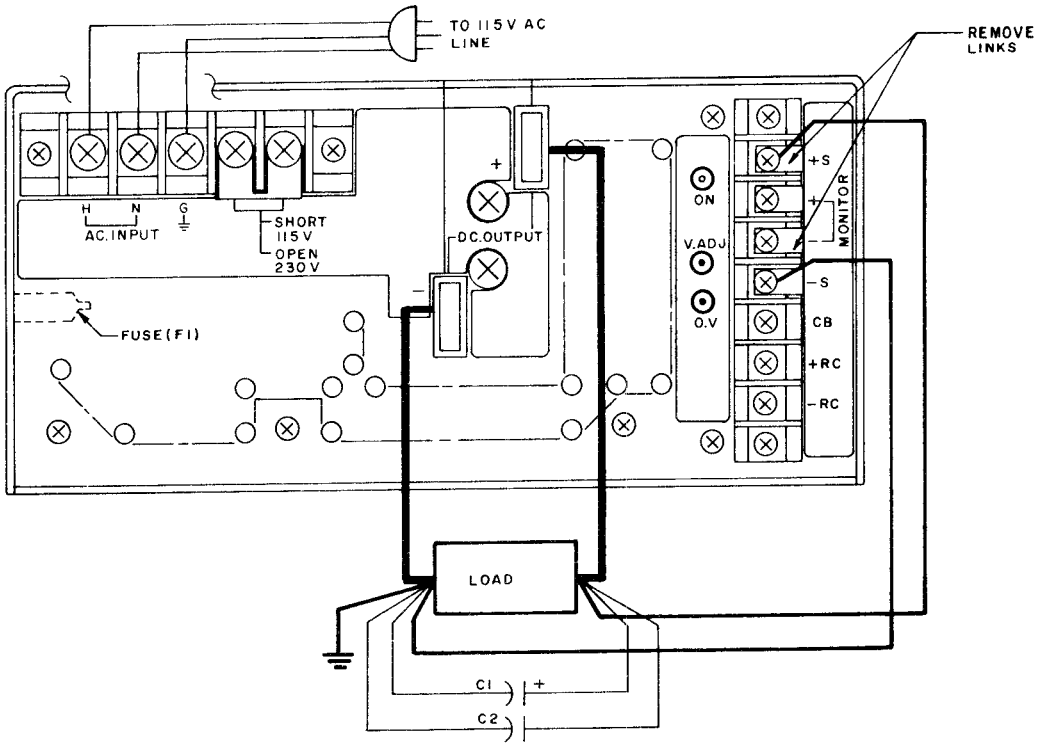



FIG. 3-1 LOAD CONNECTIONS, WITH ERROR SENSING, SINGLE RBX POWER SUPPLY.

## 3-3 LOAD WIRE SELECTION.

3-4 When drawing heavy load currents from a power supply output, great care must be taken to select the appropriate load wire for minimum temperature rise and voltage drop. In general, the heaviest practicable wire gage should be chosen.

3-5 Ideally, load connections should be made with heavy bus-bars, similar to those used as the D-C OUTPUT terminals on the RBX units. These bus-bars have a cross section of 75 $mm^2$, which is equivalent to an AWG wire gage between 00 and 000. Since bus-bars are not always feasible, a LOAD WIRE TABLE is provided (Refer to Table 3-1) which should assist the user in selecting the loadwire for the application at hand.

3-6 Load wires or bus-bars connected to the D-C OUTPUT terminals of the RBX must be properly terminated with connectors or lugs which provide maximum possible contact area. Unterminated load wires are a cause for overheating and excessive voltage drops at the output terminals. VOLTAGE DROP DUE TO LOAD CURRENT MUST NOT EXCEED 0.35V PER WIRE.

3-7 Most applications require the use of error sensing at the load (Refer to FIG. 3-1). To this end, the links between the ± MONITOR terminals and the ± SENSING terminals are removed and the ± S terminals are connected directly at the load as shown. This technique compensates for load wire drops up to 0.35V per load lead. Sensing wire pairs should be tightly twisted.

3-8 Error sensing lead diameter, although less critical, should be selected according to the distance between the power supply and the load. Wire gages in the range from AWG 22 (0.5 $mm^2$) for load distances of 15 ft (5m) or less to AWG 12 (2.5 $mm^2$) for load distances to 75 ft (25 m) are generally adequate.

| WIRE SIZE | | RESISTANCE Ω/1000 Feet or Ω/1000 Meter | CARRYING[1] CAPACITY (AMPERES) | LOAD CURRENT VS. APPR. MAXIMUM LENGHT[3] PER LOAD LEAD (FT. or M) TO KEEP VOLTAGE DROP >0.35V | | |
|---|---|---|---|---|---|---|
| AWG | CROSS SECTION ($mm^2$) | | | 25A | 60A | 120A |
| 0 | | 0.09832 | 245 | 142 ft | 59 ft | 30 ft |
| | 50 | 0.393 | 235 | 36 m | 15 m | 7 m |
| | 35 | 0.565 | 180 | 25 m | 10 m | 5 m |
| 2 | | 0.1564 | 180 | 89 ft | 37 ft | 18 ft |
| | 25 | 0.795 | 150 | 18 m | 7 m | 4 m |
| 4 | | 0.2486 | 135 | 56 ft | 24 ft | 12 ft |
| | 16 | 1.028 | 110 | 14 m | 6 m | 3 m |
| 6 | | 0.3950 | 100 | 35 ft | 15 ft | 7 ft |
| | 10 | 1.602 | 82 | 9 m | 4 m | 2 m |
| 8 | | 0.6280 | 75 | 22 ft | 9 ft | 5 ft |
| | 6 | 2.550 | 58 | 5 m | 2 m | 1 m |
| 10 | | 0.9985 | 55 | 14 ft | 6 ft | 3 ft |

TABLE 3-1 LOAD WIRE TABLE FOR STRANDED COPPER WIRE [2].

**NOTES:** [1] *Ratings for AWG wires are per MIL-W-5088B.*
*Ratings for metric wires are per IEC Publication 335-1. These ratings are for wire rated for 105°C operation at a maximum ambient temperature of 50°C.*

[2] *Carrying capacity for aluminum wire is approximately 20% lower.*

[3] *Max. length for other than listed current values may be calculated by:*

$$\text{MAX. LENGTH (FEET OR METERS)} = \frac{350}{\text{AMPERES X RESISTANCE}}$$

3-9 REFER TO FIG. 3-2A. If multiple loads are connected to a single power supply, each load should be connected to the D-C OUTPUT terminals using separate pairs of load connecting wires. This method reduces coupling effects between the loads and each load can take advantage of the power supply's low output impedance. Remote error sensing in this case should be applied to the most critical load (LOAD 1 in FIG. 3-2A).

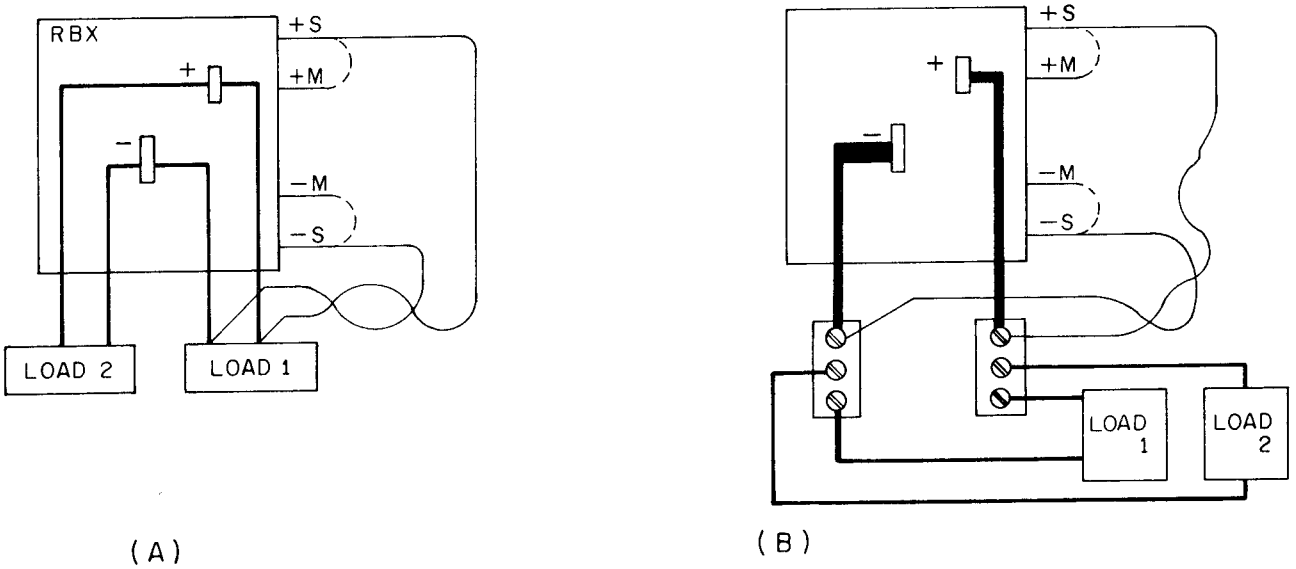



FIG. 3-2 MULTIPLE LOADS AND A SINGLE POWER SUPPLY.

3-10 REFER TO FIG. 3-2B. If conditions require a common load distribution terminal, the latter is connected to the D-C OUTPUT of the RBX as shown, using load wire rated for the sum of all load currents. Error sensing may be used at the distribution terminal as shown in FIG. 3-2B, or directly at the most critical load.

3-11 **PARALLEL OPERATION.** Identically rated RBX power supply models may be connected in parallel for increased output current into a common load (Refer to FIG. 3-3).

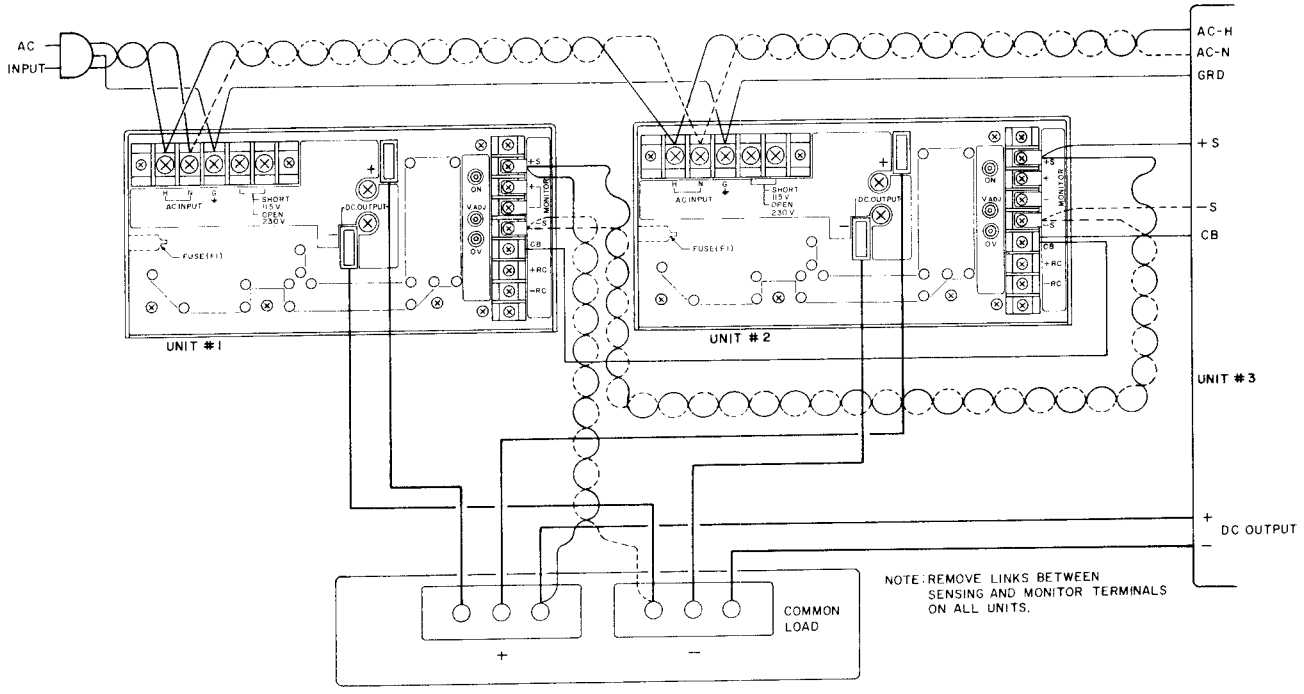



FIG. 3-3 LOAD CONNECTIONS WITH ERROR SENSING AND PARALLEL SYNCRONIZATION VIA THE "CB" TERMINAL, TWO IDENTICAL RBX MODELS SHOWN.

3-12 A parallel connection of two (2) identical RBX power supplies is shown in FIG. 3-3 to illustrate the wiring of the sync terminal (CB) and the interconnection of the error sensing terminals. **It is important to maintain strict polarity among the ± error sensing terminals.** For this reason the (−) sensing lead is shown with dashed lines.

3-13 The polarity of the a-c terminals must be preserved as well, as is indicated in FIG. 3-3 where the neutral line is shown dashed.

3-14 **GROUNDING THE OUTPUT CIRCUIT.** The specifications for ripple and noise, given in Section I, paragraph 1-7, apply at the power supply output terminals, with one output terminal grounded. For minimum ripple and noise at the load, careful selection of a common ground point is required. **There must be only a single ground point in the load circuit.** Multiple ground points result in ground loops which may cause greatly increased ripple and noise at the load. Often, an additional filter may be required directly at the load terminals (Refer to FIG. 3-1, C1 = 50$\mu$F, electrolytic type, C2 = 0.1$\mu$F, Film Type) as a low/high frequency by-pass.

3-15 Either the positive or the negative side of the output may be grounded. This supply can be operated with either output terminal up to 500V off ground.

3-16 **SERIES CONNECTION.** RBX power supplies may be connected in series for increased voltage output. To protect the supplies against short circuits in any other supply in the series connection, each supply must be protected by a parallel diode across its output. This diode must be rated for the maximum output current and voltage of all the units in the series connection. Considerations for grounding, load wire selection, additional filtering at the load and error sensing lead selection are similar as that described previously.

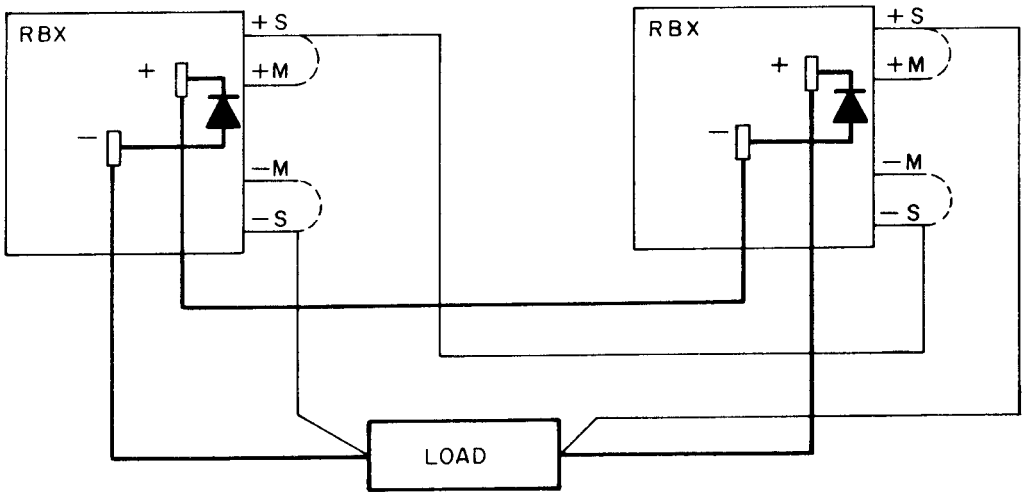



FIG. 3-4 SERIES CONNECTION OF TWO POWER SUPPLIES.

**3-17 REMOTE VOLTAGE ADJUSTMENT** (Refer to FIG. 3-5).

3-18 The output voltage of the RBX power supply may be adjusted externally by turning the internal "Vadj." control to the position yielding the low value of the range listed in Section I, paragraph 1-7 for each RBX Model and connecting an external control as shown in FIG. 3-5. The sensing leads should be tightly twisted and shielded, with the shield connected to the common ground. The values for the external Vadj. control are RBX 02: 500 ohm, RBX 05: 500 ohm, RBX 12: 500 ohm, RBX 24: 1K ohm and RBX 48: 1K ohm. These values will permit output voltage adjustment over the specified range of each RBX model. DO NOT EXCEED THE HIGH VALUE OF THE RANGE AS LISTED IN SECTION I, PARAGRAPH 1-7 FOR EACH RBX MODEL SINCE HIGHER OUTPUT VOLTAGES WILL TRIP THE OVERVOLTAGE PROTECTOR CIRCUIT.

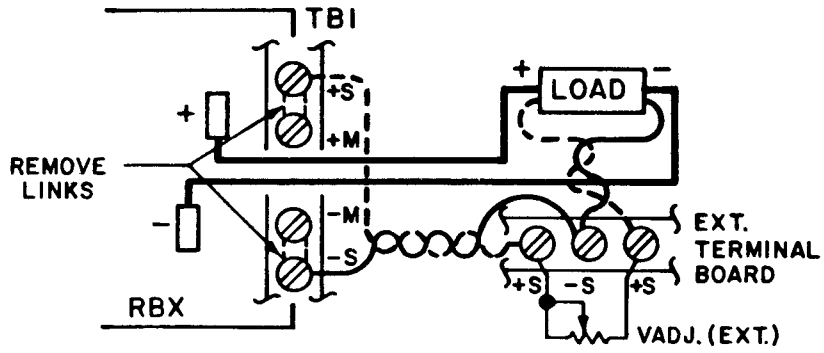



FIG. 3-5 EXTERNAL VOLTAGE ADJUSTMENT WITH SENSING AT THE LOAD.

**3-19 OVERVOLTAGE CALIBRATION ADJUSTMENT.**

3-20 The overvoltage protection circuit is factory set to the values shown under OVERVOLTAGE SETTING in Section I, paragraph 1-7.

3-21 These values permit operation with or without remote sensing and avoid premature triggering of the overvoltage circuit.

3-22 An externally accessible calibration control is available (O.V. cal, R81) which permits recalibration of the SETTING VOLTAGES if necessary after a repair affecting the overvoltage circuit, for example. This control may also be used, for special applications, if the factory calibrated SETTING VOLTAGE must be re-adjusted either closer to the output voltage, or if the threshold voltage (difference between output voltage and overvoltage trigger-point) must be increased. The APPROXIMATE RANGE for each model is given in Section I, paragraph 1-7. Refer to Section V, paragraph 5-20 for testing of the overvoltage trigger point by means of an external voltage source.