bwd

246A
DUAL D. C. POWER SUPPLY

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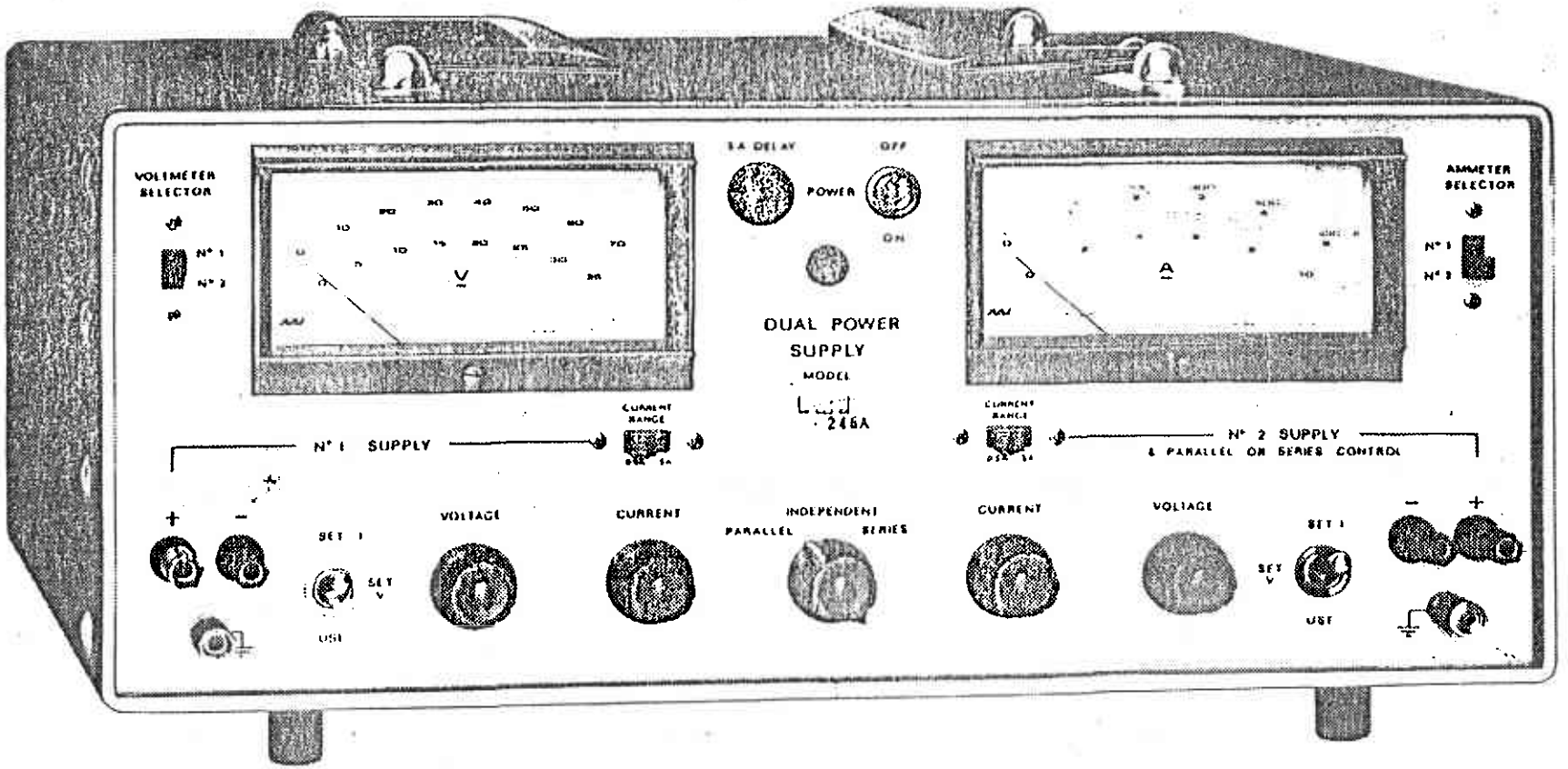

VOLTMETER SELECTOR
N° 1
N° 2
5A DELAY
OFF
POWER
ON
DUAL POWER SUPPLY
MODEL
246A
AMMETER SELECTOR
N° 1
N° 2
CURRENT RANGE
N° 1 SUPPLY
CURRENT RANGE
N° 2 SUPPLY
& PARALLEL OR SERIES CONTROL
+
−
SET V
USE
VOLTAGE
CURRENT
INDEPENDENT
PARALLEL
SERIES
CURRENT
VOLTAGE
SET V
USE
− +

INSTRUMENT HANDBOOK

MODEL BWD 246A

DC POWER SUPPLY

INDEX

INSTRUMENT HANDBOOK

MODEL BWD 246A

DC POWER SUPPLY

1. GENERAL

Model BWD 246A dual high stability, all Silicon Solid State DC Power Supply provides both Constant Voltage and Constant Current operation over the full operating range. Front panel switching enables the supply to be used up to the following ratings.

1.	INDEPENDENT	2 x 0 - 36V at 0 - 5 Amp.
2.	SERIES	0 - 72V at 0 - 5 Amp.
3.	PARALLEL	0 - 36V at 0 - 10 Amp.

Integrated Circuit control and reliable silicon semi-conductors coupled with the advanced circuit design provide very high stabilisation and regulation with low ripple.

Using a single unit, switched to any of the three modes of operation, the output may be programmed by several sources to provide the following operation.

1. Remote Load Sensing
2. Constant Voltage Remote Resistance Programming
3. Constant Voltage Remote Voltage Programming
4. Constant Current Remote Resistance Programming
5. Constant Current Remote Voltage Programming

With two or more units, not necessarily of the same Model, (see Section 4 for list of compatible supplies), the following operational modes can be used.

6. Auto Series with two or more units
7. Auto Tracking, +ve to +ve, +ve to -ve, -ve to -ve, using two or more units
8. Auto Parallel with two or more units

The MASTER SUPPLY of any of the above modes using multiple supplies may be programmed internally or by any of the modes 1 to 5.

NOTE: For reliable operation, at least 5cm of free space must be left at the rear of the heatsinks to ensure free flow of air past the power devices.

2. PERFORMANCE

2.1 Constant Voltage Output

	INDEPENDENT NOS. 1 & 2	SERIES	PARALLEL
Output current should be 100mA (200mA on PARA) less than S/C current			
Continuously variable without switching	0 - 36V	0 - 72V	0 - 36V
Current Range	0 - 5A	0 - 5A	0 - 10A
Line Regulation for a 10% line change	.002%+100µV	.005%+200µV	.005%+200µV
Output Impedance			
DC - 1kHz	1mΩ	2mΩ	1mΩ
1kHz - 10kHz	10mΩ	10mΩ	10mΩ
10kHz - 1MHz	100mΩ	100mΩ	100mΩ
Ripple at Full Load	2mV p-p	or	300µV RMS
Response Time 0 - 100% load to within 10mV of output. 20mV in Series and parallel.	60µSec	60µSec	100µSec
Temperature Stability 0 to 50°C	(0.01% + 2mV) per °C		
Long Term Stability 1,000 Hrs. Constant Load and Temperature	0.1% + 2mV		

2.2 Constant Current Output

Maximum output voltage should be 100mV below O/C voltage			
Continuously variable without switching	0 - 5.0A	0 - 5.0A	0 - 10.0A
Upper Voltage Limit	0 - 36V	0 - 72V	0 - 36V
Line Regulation for a 10% Line Change		.02% + 100µA	
Output Impedance DC-100Hz	100KΩ	10KΩ	10KΩ
Current Ripple	500µA RMS	500µA RMS	1mA RMS
Response Time 0V to Upper Voltage limit to within 4% of nominal output	See Page 4 - 3	See Page 4 - 17	See Page 4 - 29

2. PERFORMANCE cont'd.

2.3 Remote Load Sensing (Constant Voltage)

$$Ro = 2\,(2R\ lead)^2 \times 10^{-1} + 1 \times 10^{-3}\Omega$$

when: (i) All four leads (output and sensing) have identical resistance

(ii) R lead is the resistance of one lead only

(iii) Ro is the output resistance at the load

(iv) The voltage drop across any one lead does not exceed 0.5V

2.4 Remote Programming, Constant Voltage

(i) Resistance Programming:

The output voltage will vary at a rate determined by the programming coefficient 1.3kΩ per volt (i.e. the output voltage will increase one volt for each 1.3kΩ added in series with the programming terminals.
Accuracy ±10%.

(ii) Voltage Programming:

The output voltage will vary in a 1:1 ratio with the programming voltage. Accuracy within 10mV.
Slewing Rate: 10μS/V (Current Limit set to 5A)

2.5 Remote Programming, Constant Current

(i) Resistance Programming:

The output current will vary at a rate determined by the programming coefficient 335Ω approx. per amp.
Accuracy ±10%.

The upper limit on current is dependent on the constant current vernier at all times.

(ii) Voltage Programming:

The output current will vary at a rate determined by the programming coefficient 235mV approx per amp. The upper limit on current is dependent on the constant current vernier setting.
Accuracy ±5% above 1A.

2.6 Auto Series

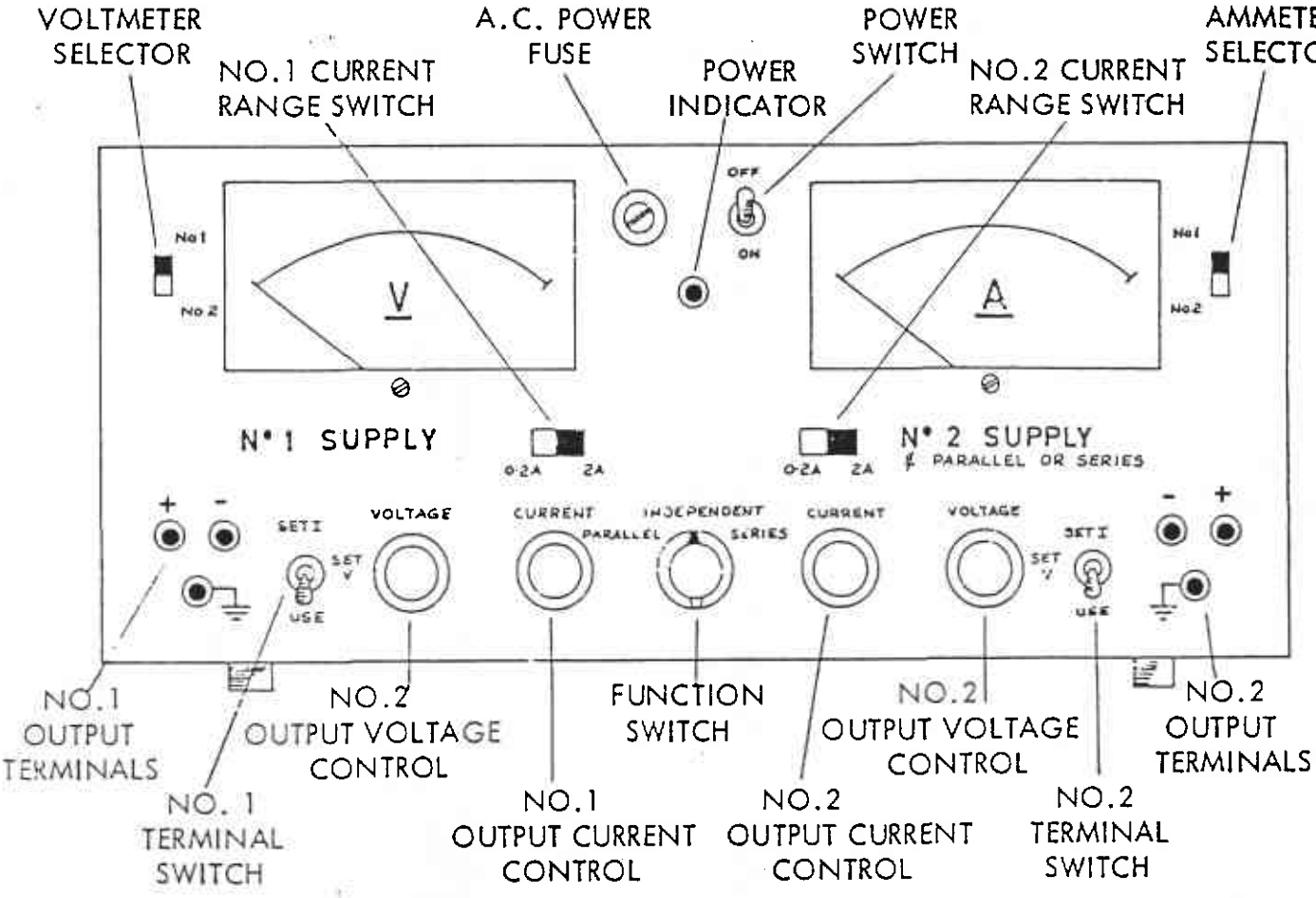
Two or more supplies may be connected in series, noting that the maximum voltage of each supply is 36V. Also, the current overloads of each supply are operative at the current set by the respective current verniers.

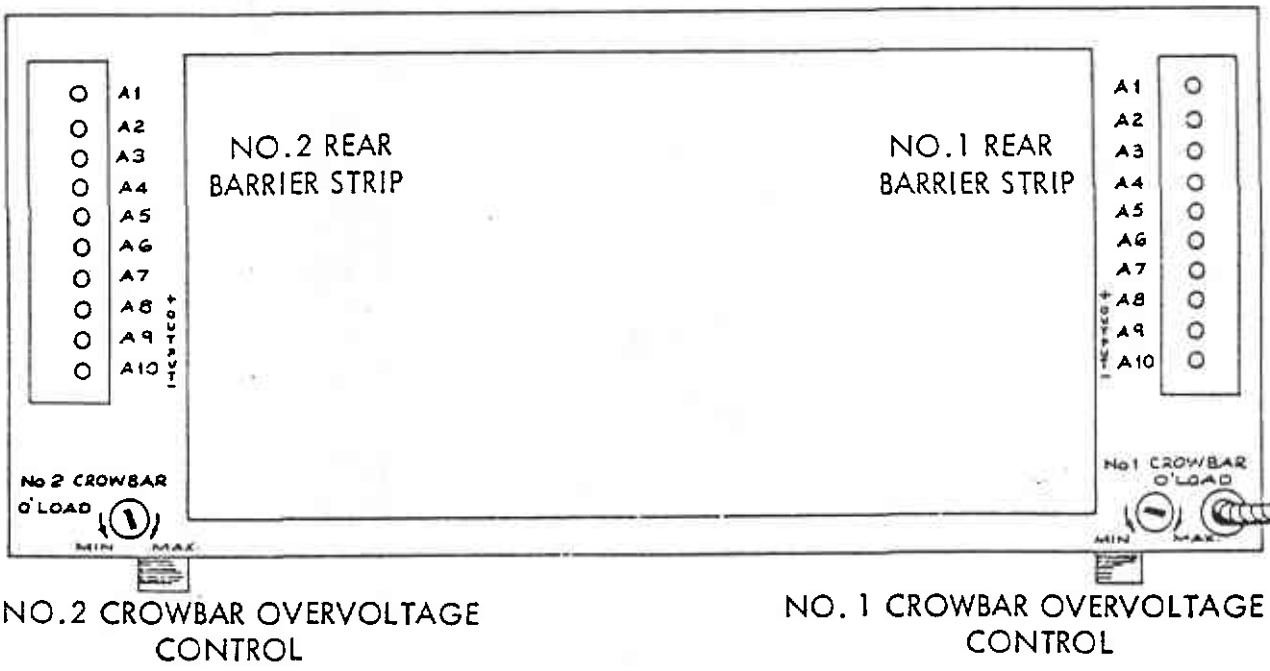
2.7 Auto Parallel

Two or more units may be connected in parallel, thereby doubling the available output current. The maximum current from each supply is dependent on the setting of the current vernier.

3. CONTROLS AND THEIR FUNCTIONS

Power On/Off:	Input power switch.
Power Fuse:	5 Amp delay fuse fitted after power switch in AC line.
Power Indicator:	6.3V lamp wired into the power transformer secondary.
Parallel, Independent, Series (Function):	Internally connects both supplies in Parallel or Series, or allows both supplies to be operated independently.
Output Voltage:	Continuously variable control to set output voltage from zero to 36V or 72V as selected by the function switch.
Output Current:	Continuously variable control to set output current from 10mA to 500mA, 5.0A as selected by Current Range Switch.
Current Range:	Selects both the maximum current output, 500mA or 5.0A, and the corresponding ammeter range.
Voltmeter Selector:	Selects either No. 1 or No. 2 output voltage for display.
Ammeter Selector:	Selects either No. 1 or No. 2 output current for display.
Set 1 - Set V - Use: (Terminal Switch)	Enables the maximum current required (Set 1) to be set and the maximum voltage (Set V) to be set without disconnecting the load from the terminals. NOTE: Vo must be greater than 1V to set "I".
Terminals:	Load - Red (positive) Black (negative) Ground - Uninsulated Terminal
Barrier Strip: (Rear Panel)	Designated A1 to A10 inclusive, the terminations provide output and remote sensing connections, together with remote control facilities.
Crowbar Overload:	Continuously variable screwdriver control sets the over-voltage overload.


VOLTMETER SELECTOR
NO.1 CURRENT RANGE SWITCH
A.C. POWER FUSE
POWER INDICATOR
POWER SWITCH
NO.2 CURRENT RANGE SWITCH
AMMETER SELECTOR
No1
No2
V
A
OFF
ON
N° 1 SUPPLY
N° 2 SUPPLY
0-2A 2A
PARALLEL OR SERIES
SET I
SET V
USE
VOLTAGE
CURRENT
INDEPENDENT
PARALLEL
SERIES
NO.1 OUTPUT TERMINALS
NO.2 OUTPUT VOLTAGE CONTROL
FUNCTION SWITCH
NO.2 OUTPUT VOLTAGE CONTROL
NO.2 OUTPUT TERMINALS
NO. 1 TERMINAL SWITCH
NO.1 OUTPUT CURRENT CONTROL
NO.2 OUTPUT CURRENT CONTROL
NO.2 TERMINAL SWITCH


A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
NO.2 REAR BARRIER STRIP
NO.1 REAR BARRIER STRIP
No 2 CROWBAR O'LOAD
No1 CROWBAR O'LOAD
MIN
MAX
NO.2 CROWBAR OVERVOLTAGE CONTROL
NO. 1 CROWBAR OVERVOLTAGE CONTROL

4. OPERATION

NOTE: This unit has been fitted with crowbar overloads which is now a standard fitting. Before using the unit, read Section 9, Para 5, Page 9-1 for the setting up procedure, or if the crowbar facility is not required, ensure that the crowbar control is turned fully anti-clockwise until it is switched OFF.

4. OPERATION cont'd.

4.1 GENERAL

For reliable operation, ensure that at least 5cm of free space is present at the rear of the heatsinks and that adequate ventilation above and below the heatsinks is provided. For rack mounted units, do not operate above equipment producing heat in excess of 50°C in the vicinity of the heatsinks.

NOTE: Check that the mains voltage connections are correct for the supply in your location.

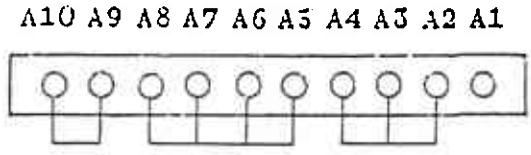
4.2 INDEPENDENT - Constant Voltage (0-36V, 0-5A)

Set the function switch to "INDEPENDENT", the terminal switch to "SET V", the current range to the desired current output range and the meter selectors to the required supplies.

Switch the Power Switch "ON" and set the required output voltage via the output voltage control and the front panel meter. Switch the terminal switch to "SET I" and set the required overload current with the output current control.

Connect the load to either the output terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

NOTE: When using the rear barrier strip for load termination, make sure that the following terminals are linked.



Switch the terminal switch to "USE".

If the output voltage drops to less than that set earlier, the load is drawing more current than allowed for.

If the load is to be operated at a considerable distance from the power supply and the output impedance required is to be as low as possible, remote sensing may be employed; see Section 4.4.

4.3 INDEPENDENT - Constant Current (0-5A, 0-36V)

Set the function switch to "INDEPENDENT", the terminal switch to "SET V", the current range to the desired current output range and the meter selectors to the required supplies.

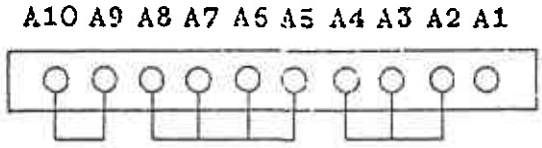
Switch the power switch "ON" and set the maximum voltage limit required by the Output Voltage Control and the front panel meter. Switch the terminal switch to "SET I" and set the required output current by the output current control and the front panel meter.

Connect the load to either the output terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

4. OPERATION cont'd.

4.3 INDEPENDENT - Constant Current (0-5A, 0-36V) cont'd.

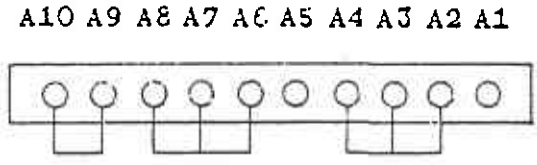
NOTE: When using the rear barrier strip for load termination, make sure that the following terminals are linked.

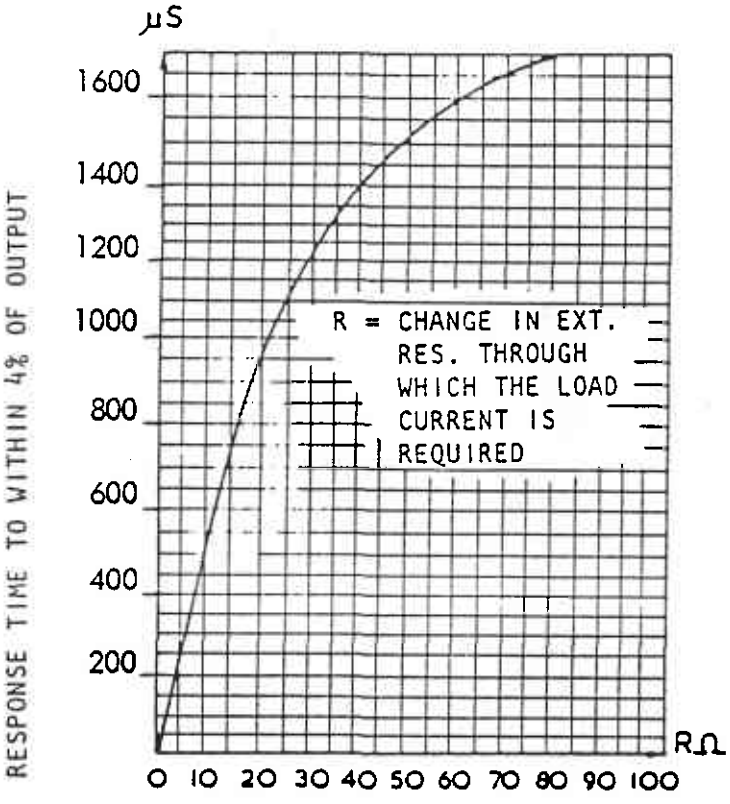


Switch the terminal switch to "USE".

If the output current is less than that set previously, the load impedance is higher than expected. To enable sufficient current to be drawn, the upper voltage limit may be increased until correct operation is achieved.

With the rear barrier strip linking above, the output capacitance is approximately 2200μF. This high capacity produces a long response time for rapid load changes. To reduce the output capacity the link on the rear barrier strip joining A5 to A6 (see below) is removed, giving a much improved transient response time.



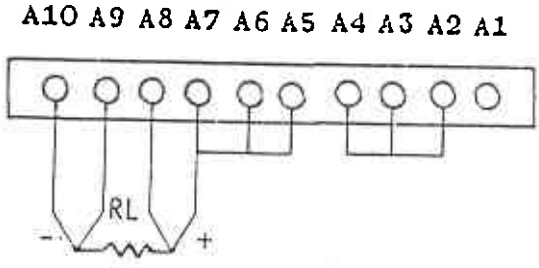


4.4 INDEPENDENT - Remote Load Sensing (0-36V, 0-5A)

This mode of operation is only required when the supply is used in the constant voltage mode and the lead resistance between the load and the power supply is excessive.

4.4 INDEPENDENT - Remote Load Sensing (0-36V, 0-5A) cont'd.

Set the function switch to "INDEPENDENT", the terminal switch to "SET V", the current range to the desired current output range and the meter selectors to the required supplies. Connect the load as below from the rear barrier strip only.



NOTE:
1. All four leads must have same resistance.
2. To reduce hum pickup, shield all leads or twist together.

The output resistance at the load can be calculated quite closely using the following equation:-

$$Ro = 2\ (2R)^2 \times 10^{-2} + 1 \times 10^{-3} \quad \Omega$$

where Ro is the output resistance as seen at the load.

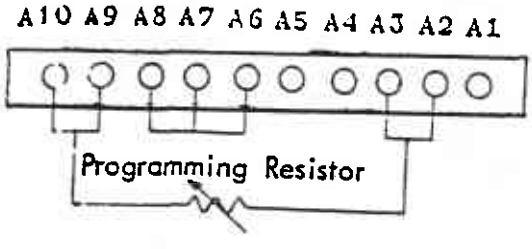
R is the resistance of one lead in ohms, assuming all four leads have identical resistance.

To supply power to the load, switch the terminal switch to "USE".

4.5 INDEPENDENT - Constant Voltage Remote Programming

Resistance Programming (0-36V, 0-5A)

The constant voltage output of the supply can be controlled from a resistance situated at a remote location. With the power supply switched "OFF" connect the programming resistor and rear barrier strip links as shown below.



Programming Coefficient is equal to approximately 1.3kΩ per volt.

Set the function switch to "INDEPENDENT", the terminal switch to "USE", the current range to the desired current output range and the meter selectors to the required supplies. Connect the load to either the front panel terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

4. OPERATION cont'd.

4.5 INDEPENDENT - Constant Voltage Remote Programming cont'd.

Resistance Programming (0-36V, 0-5A) cont'd.

NOTE: a. The terminal switch must be in the "USE" position at all times. High output voltage transients may occur across the load if the terminal switch is used.

b. Use the power ON-OFF switch if it is required to remove voltage from the load.

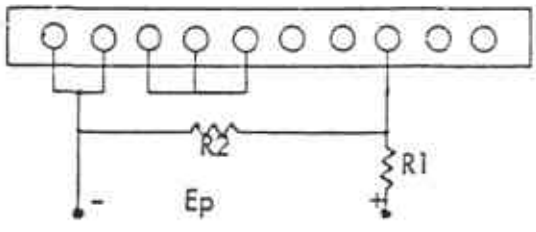
c. The maximum current may be set using the terminal switch, the load should be disconnected if high voltage transients can cause damage to it.

4.6 INDEPENDENT - Constant Voltage Remote Programming

Voltage Programming (0-36V, 0-5A)

The constant voltage output of the supply can be controlled by a variable voltage produced at a remote source. The voltage gain of the system can be either greater, equal to, or less than unity depending on the connection of the rear barrier strip.

A10 A9 A8 A7 A6 A5 A4 A3 A2 A1



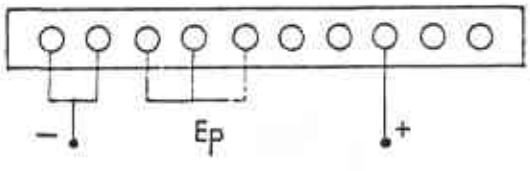
$E_{out} = E_p \dfrac{R2}{R1 + R2}$

$A_v = \dfrac{R2}{R1 + R2}$

Programming Voltage

Av < 1

A10 A9 A8 A7 A6 A5 A4 A3 A2 A1



$E_{out} = E_p$

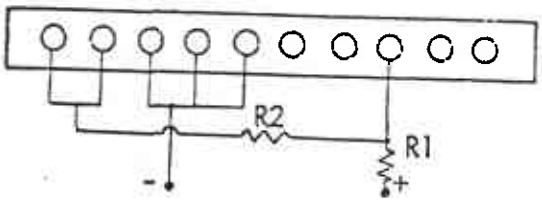
Programming Voltage

Av = 1

4.6 INDEPENDENT - Constant Voltage Remote Programming cont'd.

Voltage Programming (0-36V, 0-5A) cont'd.

A10 A9 A8 A7 A6 A5 A4 A3 A2 A1



$$E_{out} = E_p \frac{R2}{R1}$$

$$A_v = \frac{R2}{R1}$$

Programming Voltage

$A_v > 1$

NOTE: a. The maximum gain advisable is 500.
b. If a circuit ground is required at high gain, ground A8.

The output voltage in all of the voltage programming modes may be obtained at either the front panel terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

Before connecting the supply to the programming voltage, check that the DC conditions of the programming voltage and the power supply are correct, i.e. one side of the programming source (-ve) is connected to either the +ve or -ve output of the supply, ensure that the supply and the programming source do not become short circuited or cross connected by multiple ground connections. Set the function switch to "INDEPENDENT", the terminal switch to "USE", the current range to the desired current output, and the meter selectors to the required supplies. Connect the load to either the front panel terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip. With the power supply switched "OFF" connect the programming voltage into the rear barrier strip in either of the three modes.

NOTE: a. The terminal switch must be in the "USE" position at all times to avoid damage to the load.

b. Use the power ON-OFF switch if it is required to remove voltage from the load.

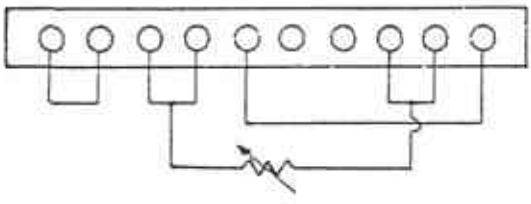
c. The maximum current may be set using the terminal switch, the load should be disconnected if high voltage transients can cause damage to it.

4.7 INDEPENDENT - Constant Current Remote Programming

Resistance Programming (0-5A, 0-36V)

The constant current output of the supply can be controlled by a resistance situated at a remote location. With the power supply switched "OFF" connect the programming resistor and rear barrier strip links as shown below.

A10 A9 A8 A7 A6 A5 A4 A3 A2 A1



Programming Coefficient is equal to approximately 340 Ohms approx. per amp.

Programming Resistor

Set the function switch to "INDEPENDENT", the terminal switch to "SET V", the current range to the desired maximum current and the meter selectors to the required supplies. Connect the load to either the front panel terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

NOTE: The maximum current of the supply is still set by the normal current controls. To check the operation the terminal switch may be set to "SET I" and the programming verified. Power may be connected to the load by setting the terminal switch to "USE".

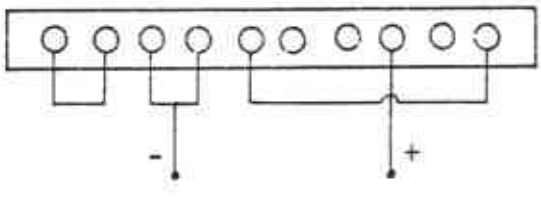
NOTE: The upper voltage limit of 36V may be exceeded with no damage to the supply. However, output ripple and regulation will be impaired.

4.8 INDEPENDENT - Constant Current Remote Programming

Voltage Programming (0-5A, 0-36V)

The constant current output of the supply can be controlled by a variable voltage produced at a remote source. With the power supply switched "OFF" connect the programming voltage and rear barrier strip links as shown below.

A10 A9 A8 A7 A6 A5 A4 A3 A2 A1



Programming Coefficient is equal to approximately 235mV per Amp.

Programming Voltage

NOTE: Check that multiple ground paths do not cause excessive loading on the programming source or the supply.

4.8 INDEPENDENT - Constant Current Remote Programming cont'd.

Voltage Programming (0-5A, 0-36V) cont'd.

Set the function switch to "INDEPENDENT", the terminal switch to "SET V", the current range to the desired maximum current and the meter selectors to the required supplies. Connect the load to either the front panel terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip.

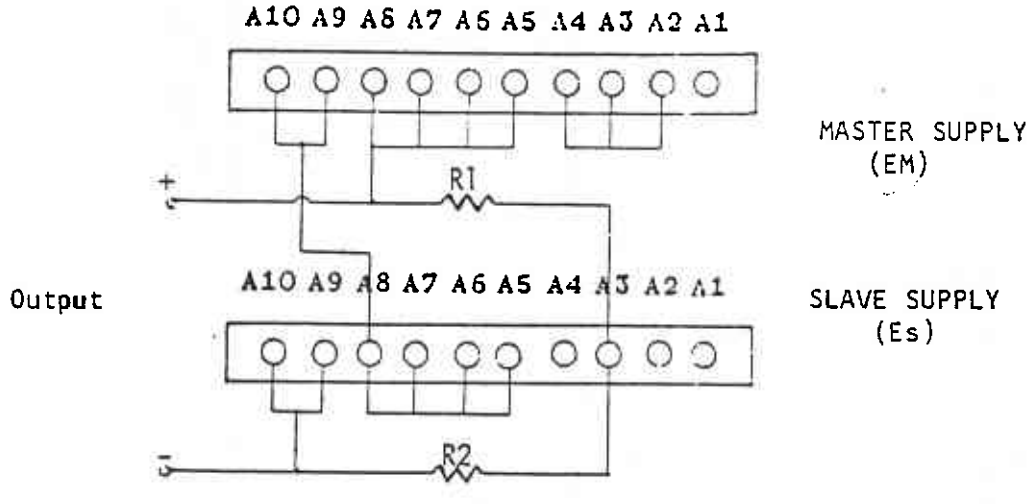
NOTE: The maximum current of the supply is still set by the normal current controls.

To check the operation, the terminal switch may be set to "SET I" and the programming verified. Power may be connected to the load by setting the terminal switch to "USE". The upper voltage limit of 36V may be exceeded with no damage to the supply. However, output ripple and regulation will be impaired.

4.9 INDEPENDENT - Auto Series (0-72V, 0-5A)

With the unit switched to "INDEPENDENT", the separate supplies (No. 1 and No. 2) may be externally connected in an automatic series configuration to enable twice the output voltage of the MASTER SUPPLY to be produced. Auto Series operation is not limited to two sections of one unit but may be used for seriesing two or more supplies from any number of units. Normally auto series operation demands that an equal voltage appears across each supply. However, by selection of various resistors the slave supplies may be made to supply varying proportional voltages to the master output. This facility may be useful where a Model BWD 246A is required to operate in auto series with another BWD power supply. For a list of compatible supplies see Section 4.32. If another model supply is used, set its front panel controls as indicated for this type of programming in the handbook for that supply.

To connect two supplies in auto series, the rear barrier strip links and resistors are connected as shown overleaf with both supplies switched "OFF".



4.9 INDEPENDENT - Auto Series (0-72V, 0-5A) cont'd.

1. IMPORTANT! Use only SINGLE POINT EARTHING.

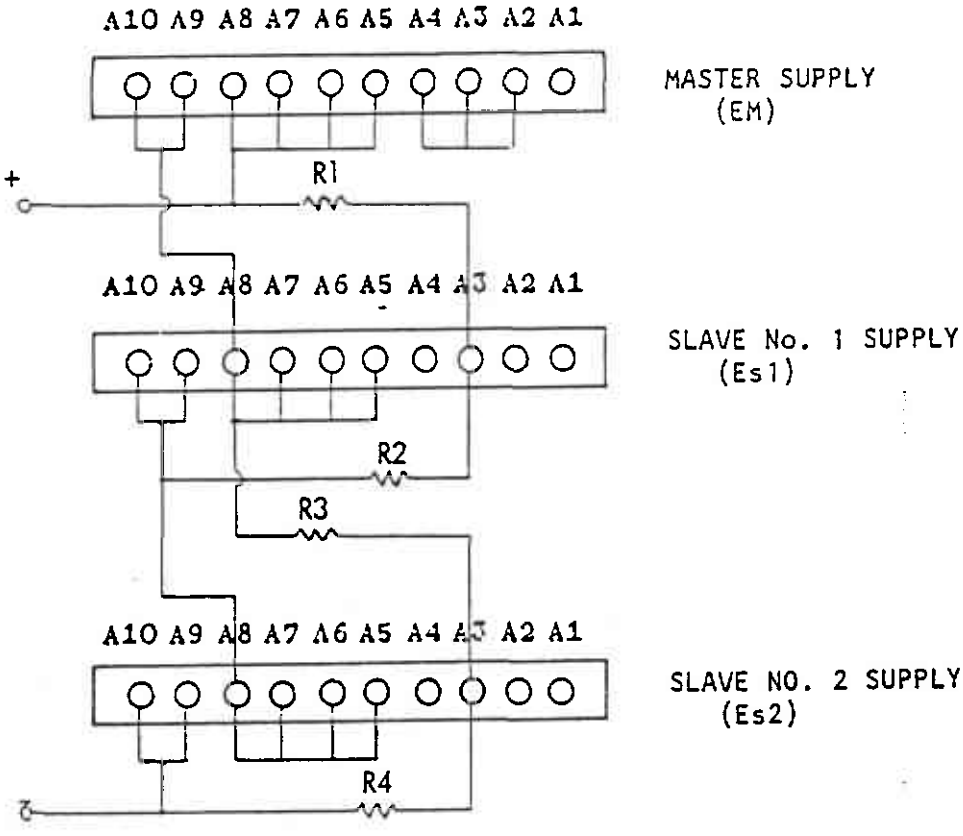
2. For equal voltages from both supplies R1 = R2 = 47KΩ.

3. If the slave supply is required to vary over a different range than the master, the values of R1 and R2 may be selected.

$$\frac{Em}{R_1} = \frac{Es}{R_2}$$ i.e. the ratio of Em to Es is equal to the ratio of R_1 to R_2.

Where Em > Es and R1 <50KΩ.

To connect three supplies in Auto Series, the rear barrier strip links and resistors are connected as shown below with all supplies switched "OFF".



1. IMPORTANT! Use only SINGLE POINT EARTHING.

2. For equal voltages from all supplies
$R_1 = R_2 = R_3 = R_4 = 47K\Omega$.

3. If the slave supplies are required to vary over different ranges than the master supply, the values of R_1 to R_4 inclusive may be selected.

$$\frac{EM}{R_1} = \frac{Es1}{R_2}$$ Where EM >Es_1 and R_1 <50KΩ.

and $$\frac{Es1}{R_3} = \frac{ES2}{R_4}$$ Where Es1 >Es2 and R_3 <50KΩ.

4.9 INDEPENDENT - Auto Series (0-72V, 0-5A) cont'd.

3. cont'd.

If $R_2 = R_3$ we have:-

$$\frac{EM}{R_1} = \frac{Es1}{R_2} = \frac{Es2}{R_4}$$ Where EM >Es1 >Es2 and R_1 <50KΩ.

When using two or more supplies in auto series, the front panel controls of all supplies (units) concerned should be set as follows:-

Set the function switch to "INDEPENDENT", the terminal switch to "USE", all current range switches to the same range (if using different models use lowest current rated supply as the MASTER and set SLAVES to slightly higher max. current output). For best operation the MASTER supply should be set to the required current overload and the SLAVE supplies to a slightly higher output. This prevents the output dropping in steps as each current limit is reached. Set the meter selectors to the required supplies. When all supplies are operating in the constant voltage mode, any one ammeter will indicate the total load current plus the current drawn by R1, 2, 3 and 4. To monitor the total output voltage, all the separate supply voltages may be summed (by using the individual voltmeters), or an external voltmeter used. Connect the load between the indicated points and switch ON the SLAVE UNITS. The entire system may now be energised by switching the MASTER UNIT ON.

DO NOT ADJUST THE SLAVE UNITS IN ANY WAY WHILST THE SYSTEM IS OPERATING WITH A LOAD CONNECTED, AS DAMAGE TO THE LOAD MAY RESULT.

The maximum current of each supply is set by the current control for that supply. With the load disconnected the terminal switch of each supply may be switched to "SET I" and the current set. Remember to switch back to "USE" before connecting the load to the output.

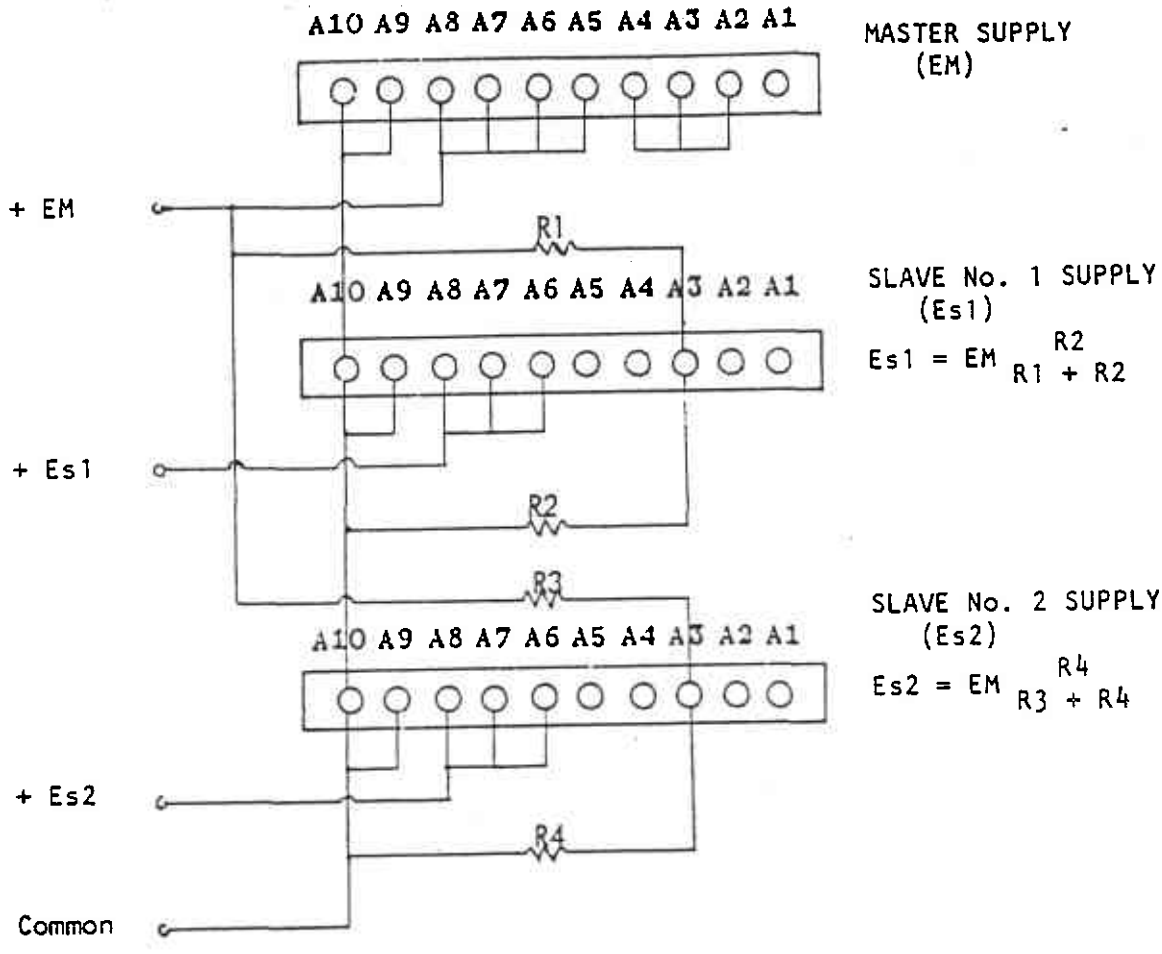
4.10 INDEPENDENT - Auto-Tracking (2 x 0-36V, 0-5A)

The Auto-Tracking mode of operation is used when several different voltages referred to a common line must vary proportionally with the setting of one supply. The MASTER SUPPLY must have the largest positive output voltage of any in the group and it must also be the most positive.

The general principle in auto-tracking is for the largest positive supply to be used as the programming source for all the SLAVE SUPPLIES which are operated in the Constant Voltage Remote Voltage Programming mode. For negative tracking supplies the Auto Series configuration is used to provide a +, - tracking supply. The interconnection of the two types of Auto-Tracking (i.e. + to + tracking and + to - tracking) will be shown separately. However, using the same MASTER SUPPLY to provide the programming source a large number of positive and negative outputs can be made to Auto-Track.

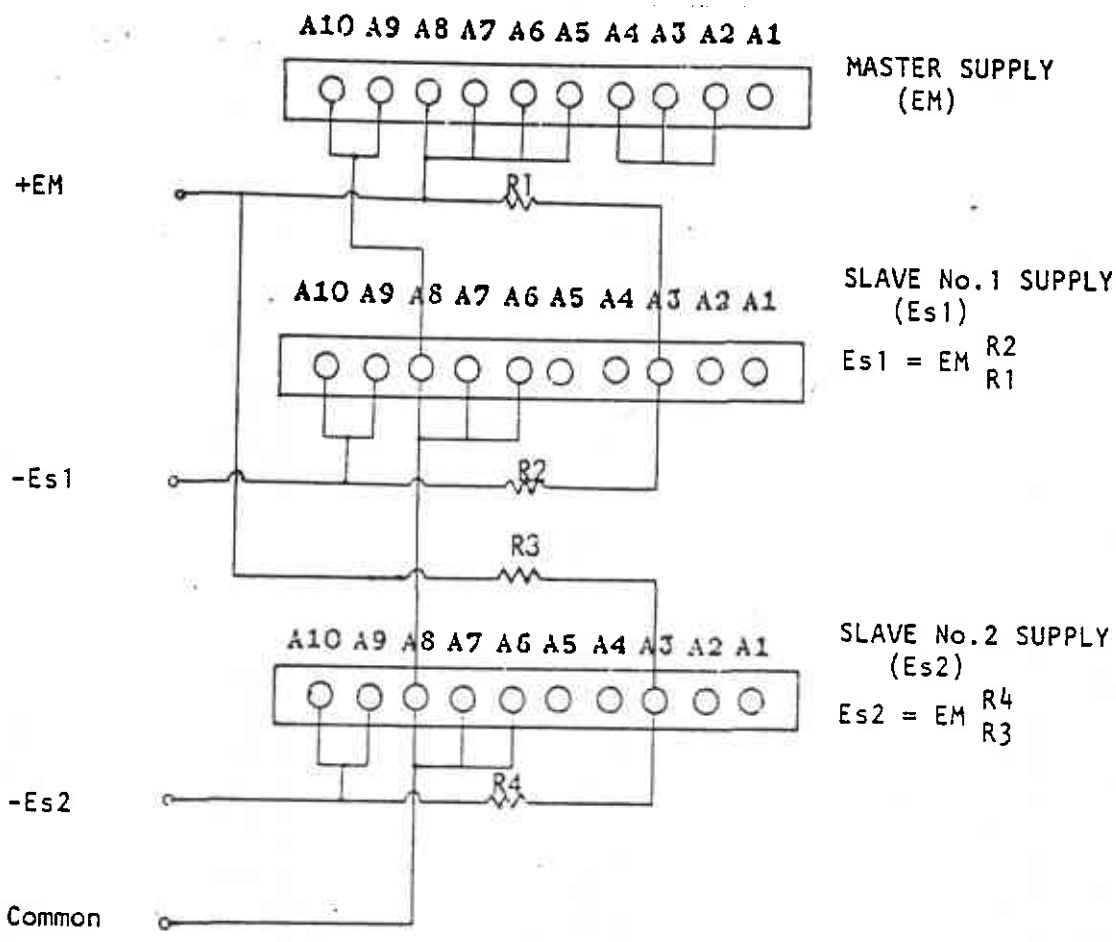
4. OPERATION cont'd.

4.10 INDEPENDENT - Auto-Tracking (2 x 0-36V, 0-5A) cont'd.



NOTE: This configuration may be extended to any number of slave units all using the MASTER SUPPLY as their programming source.

4.10 INDEPENDENT - Auto Tracking (2 x 0-36V, 0-5A) cont'd.



NOTE: The magnitude of the SLAVE SUPPLY output may be greater or less than "EM" depending on the value of the resistors.

This configuration may be extended to any number of slave units all using the MASTER SUPPLY as their programming source.

For equal voltages from all supplies $R_1 = R_2 = R_3 = R_4 = 47K\Omega$.

If both positive and negative supplies are required to track from the MASTER SUPPLY the connection to the MASTER SUPPLY is as for the particular SLAVE SUPPLY required noting that the MASTER SUPPLY is always the most positive.

With the supplies switched OFF the interconnections between MASTER and SLAVE supplies is carried out.

4. OPERATION cont'd.

4.10 INDEPENDENT - Auto Tracking (2 x 0-36V, 0-5A) cont'd.

The front panel controls are set as follows for all units connected together. Set the function switch to "INDEPENDENT", the terminal switch to "USE", the current range to the desired maximum current and the meter selectors to the required supplies. The CURRENT OUTPUT CONTROL of each SLAVE SUPPLY sets the maximum current for that supply and should one SLAVE SUPPLY operate into the constant current region it will not alter the output of any other associated supplies. However, should the MASTER SUPPLY output change for any reason all the SLAVE SUPPLIES will change in a proportional manner.

NOTE: Switch ON all SLAVE UNITS and check for 0v ±100mV output from all units. Set the VOLTAGE CONTROL on the MASTER SUPPLY to minimum (c.c.w.) output and switch ON the MASTER UNIT: If the MASTER UNIT contains a SLAVE SUPPLY re-check for zero output. Increase the MASTER SUPPLY output to the desired level and check all the SLAVE SUPPLIES for correct output.

NOTE: The terminal switches MUST remain in the "USE" position, except when checking and setting max. current output. They should not be operated when a load is connected since unwanted transients may occur.

A standby operation on all supplies simultaneously may be achieved by switching the MASTER SUPPLY "OFF". This ensures the SLAVE SUPPLIES follow the MASTER both on switch "ON" and on switch "OFF".

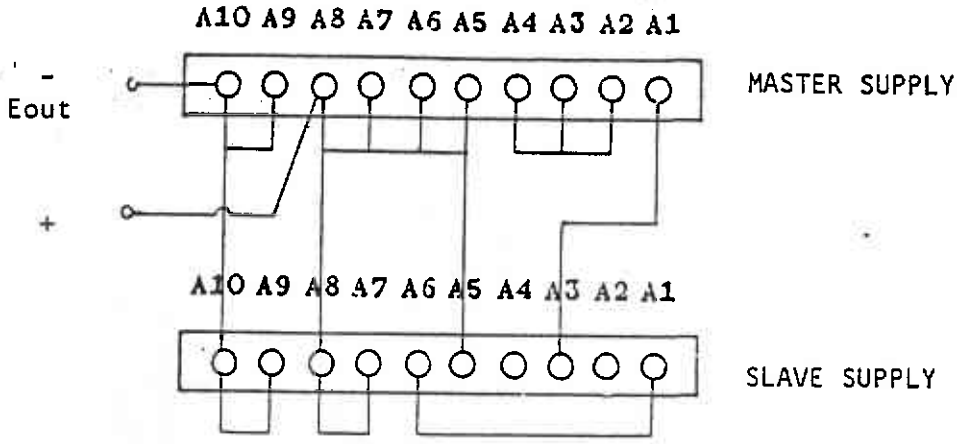
The loads may be connected with the MASTER switched "OFF" and Auto Tracking operation commenced when the MASTER SUPPLY is switched "ON".

4.11 INDEPENDENT - Auto Parallel (0-36V, 0-10A)

With the unit switched to INDEPENDENT the two separate supplies (NO. 1 and NO. 2) may be externally connected in an automatic parallel configuration to enable twice the output current of the MASTER SUPPLY to be produced. Auto Parallel operation is not limited to two sections of one unit, but may be used for paralleling two or more supplies from any number of units. Normally auto parallel operation infers that each supply produces an equal output current. However, this situation is not necessarily the case since any of the power supplies in Section 4.32 may be auto paralleled with any other supply on the compatibility list. When joining dissimilar units in auto parallel each SLAVE UNIT will supply its maximum rated current when the MASTER SUPPLY is supplying its maximum rated current. The front panel controls for any unit other than BWD 246A should be set according to its own handbook for this type of programming.

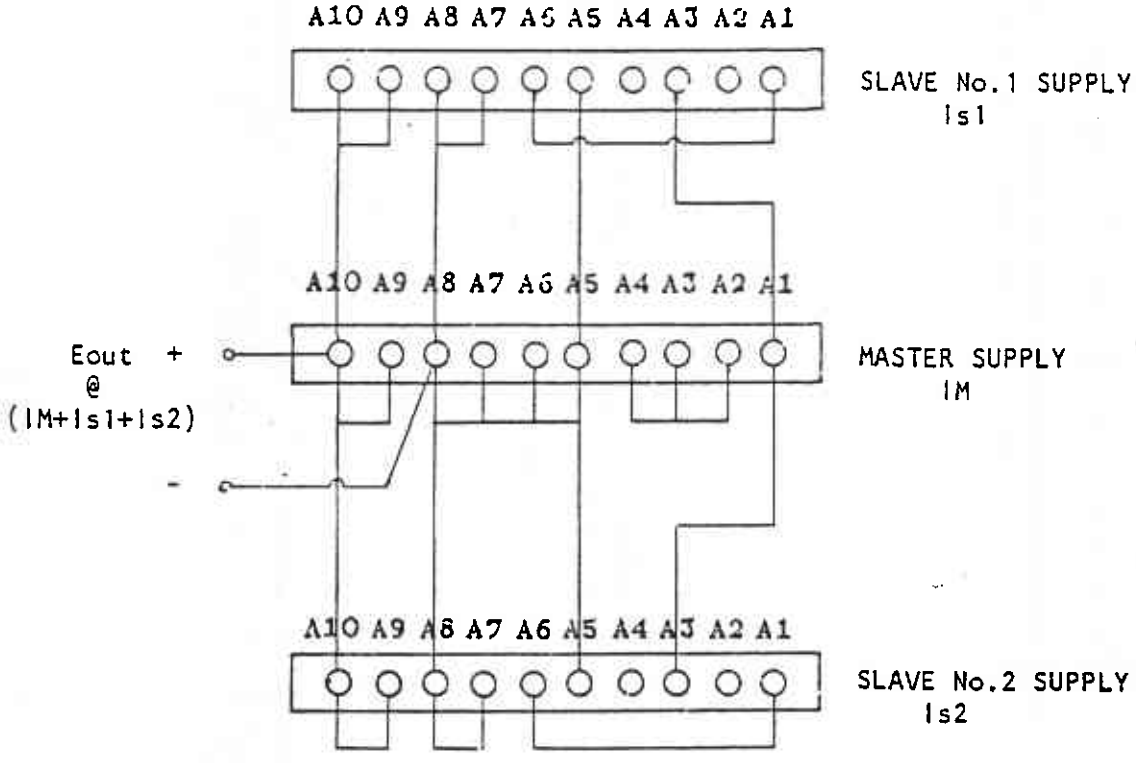
Switch "OFF" all supplies that are to be connected in auto parallel. On each supply set the function switch to "INDEPENDENT", the terminal switch to "USE", the current range switch to the maximum output and the meter selectors to the required supplies. The connection diagram overleaf shows two supplies in auto parallel.

4.11 INDEPENDENT - Auto Parallel (0-36V, 0-10A) cont'd.



The total output current can be determined by summing the two individual currents. If dissimilar supplies are used there may be a large difference in the two currents. Either the high current or the low current supply will function as the MASTER SUPPLY with equally good results.

For three or more paralleled supplies each of the SLAVE SUPPLIES should be returned independently to the MASTER SUPPLY.



4.11 INDEPENDENT - Auto Parallel (0-36V, 0-10A cont'd.

With the load disconnected, switch "ON" the SLAVE SUPPLY(IES). Eout should be 0v ±100mV. Turn the OUTPUT VOLTAGE CONTROL on the MASTER SUPPLY to minimum (c.c.w.) output and switch "ON" the MASTER UNIT. (If a SLAVE SUPPLY is contained within the MASTER UNIT check the zero volt reading before continuing).

Set the MASTER SUPPLY to the correct output level and switch the MASTER SUPPLY "OFF".

NOTE: The terminal switches MUST remain in the "USE" position except when checking and setting max. current output. They should not be operated when a load is connected since unwanted transients may occur.

A standby operation on all supplies simultaneously may be achieved by switching the MASTER SUPPLY "OFF". This ensures a transient free rise and fall of output. The load may be connected and the MASTER SUPPLY switched "ON" to supply power to the load.

NOTE: The CURRENT OUTPUT CONTROL on each supply is still operative and will set the maximum current available from each supply.

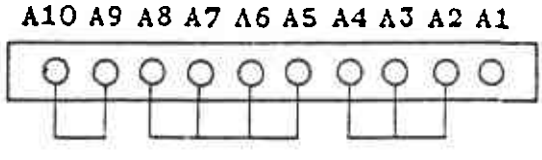
4.12 PARALLEL - Constant Voltage (0-36V 0-10A)

Set the function switch to "PARALLEL", both terminal switches to "SET V" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

Switch the power switch "ON" and set the required output voltage via No. 2 Output Voltage Control and the front panel meter. Switch No. 2 terminal switch to "SET I" and set the required overload current with No. 2 Output Current Control and the front panel meter.

Check that the rear barrier strips (No. 1 and No. 2) are both wired as shown below and if an alteration is to be made, switch the power switch "OFF".



The load may be connected to either No. 2 output terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip of No. 2 Supply ONLY.

Switch No. 2 terminal switch to "USE".

If the output voltage drops to less than that set earlier the load is drawing more current than allowed for.

4.12 PARALLEL - Constant Voltage (0-36V 0-10A cont'd.

If the load is to be operated at a considerable distance from the power supply and the output impedance required is to be as low as possible, Remote Sensing may be employed; see Section 4.14.

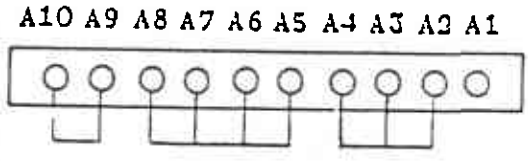
4.13 PARALLEL - Constant Current (0-36V - 0-10A)

Set the function switch to "PARALLEL", both terminal switches to "SET V" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

Switch the power supply "ON" and set the maximum voltage limit required by the Output Voltage Control and the front panel meter. Switch No. 2 terminal switch to "SET I" and set the required output current by the Output Current Control and the front panel meter which automatically reads 10 amp F.S.D.

Check that the rear barrier strips (No. 1 and No. 2) are both wired as shown below and if an alteration is to be made switch the power switch "OFF".



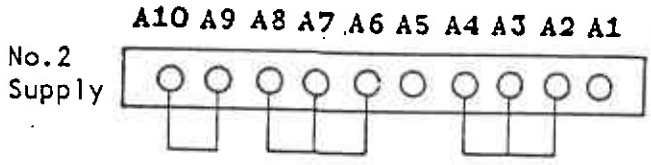
The load may be connected to either No. 2 output terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip of No. 2 Supply ONLY.

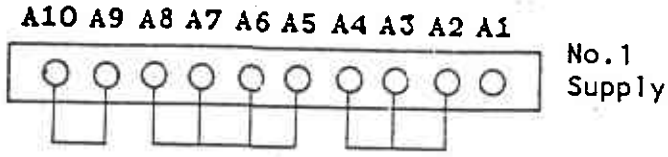
Switch No. 2 terminal switch to "USE".

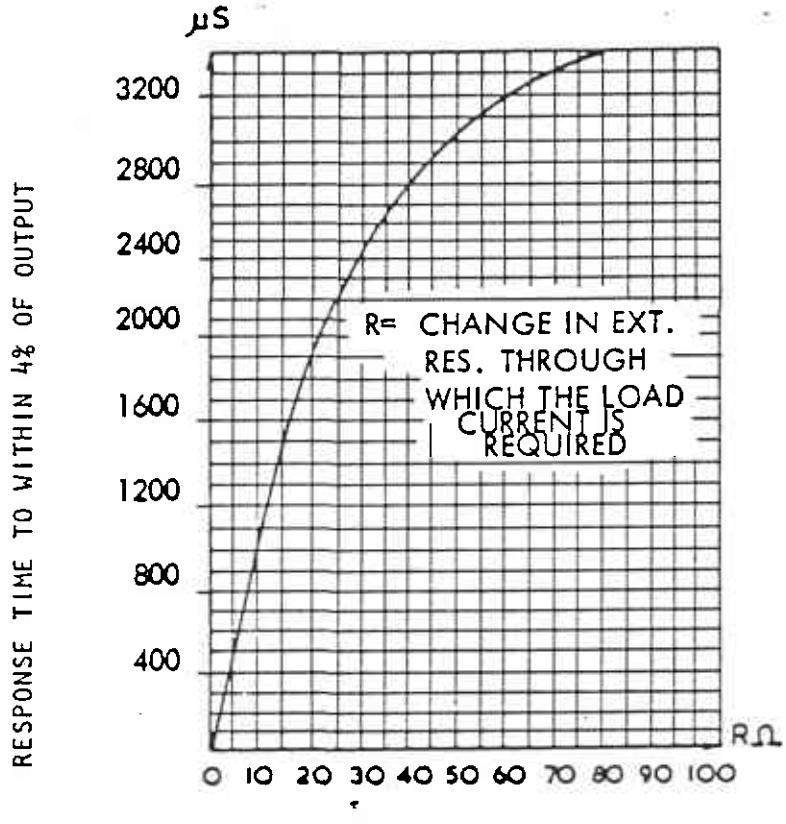
If the output current is less than that set previously, the load impedance is higher than expected. To enable sufficient current to be drawn the upper voltage limit may be increased until correct operation is achieved.

With the rear barrier strip linking below, the output capacitance is approximately 2200µF. This high capacity produces a long response time for rapid load changes. To reduce the output capacity the link on No. 2 rear barrier strip joining A5 to A6 (see below) is removed, giving a much improved transient response time.

4.13 PARALLEL - Constant Current (0-36V 0-10A) cont'd.







Constant Current

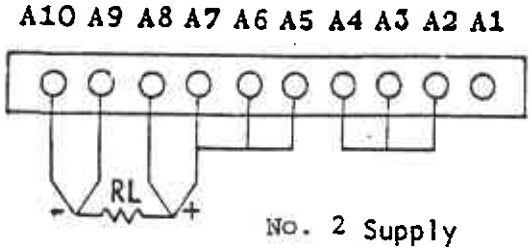
Transient Response Time

4.14 PARALLEL - Remote Load Sensing (0-36V 0-10A)

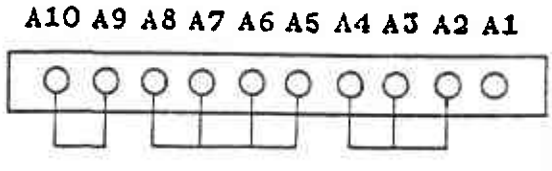
This mode of operation is only required when the supply is used in the Constant Voltage mode and the lead resistance between the load and the power supply is excessive.

Set the function switch to "PARALLEL", both terminal switches to "SET V" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply. Connect the load as below from No. 2 rear barrier strip only.



No. 2 Supply



No.1 Supply

NOTE: 1. All four leads must have same resistance.

2. To reduce hum pickup, shield all leads or twist together.

4.14 PARALLEL - Remote Load Sensing (0-36V 0-10A) cont'd.

The output resistance at the load can be calculated quite closely using the following equation:-

$$RO = 2(2R)^2 \times 10^{-2} + 1 \times 10^{-3}\Omega$$

Where RO is the output resistance as seen at the load.

R is the resistance of one lead in Ohms, assuming all four leads have identical resistance.

Switch the Power Switch "ON".

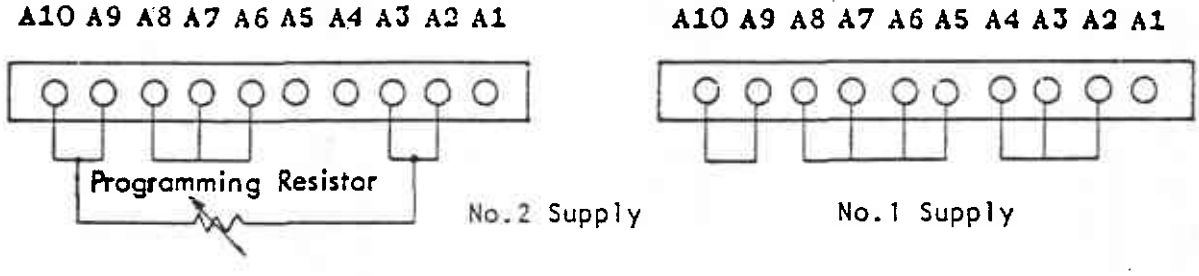
If the output voltage drops to less than that set earlier, either the load is drawing excess current or the lead resistance is too high (0.5V max. is a typical figure).

4.15 PARALLEL - Constant Voltage Remote Programming

Resistance Programming (0-36V, 0-10A)

Set the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply. Connect the programming resistor and rear barrier strip links as shown below and take the output from the No. 2 output terminals or A8 (+ve) and A10 (-ve) on No. 2 rear barrier strip.



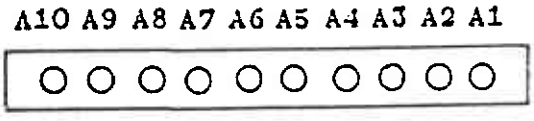
NOTE: DO NOT alter barrier strip connections with unit switched "ON". See "NOTE" - Section 4.5 using No. 2 Supply ONLY.

4.16 PARALLEL - Constant Voltage Remote Programming

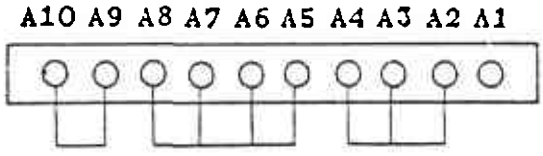
Voltage Programming (0-36V 0-10A)

Set the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply. With the power switch "OFF", connect the rear barrier strip as shown below and take the output from the No. 2 output terminals or A8 (+ve) and A10 (-ve) on No. 2 rear barrier strip.



See Section 4.6 for connection of No. 2 Supply



No. 1 Supply

All of the three types of Voltage programming described in Section 4.6 are applicable to PARALLEL operation.

USE ONLY NO. 2 CONTROLS AND CONNECTIONS

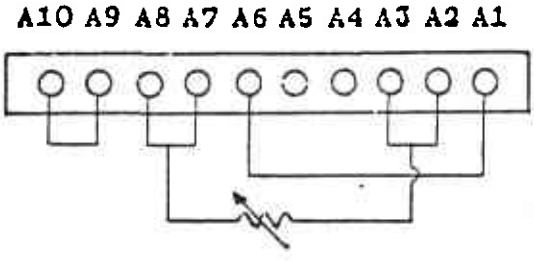
See "NOTE":- Section 4.6.

4.17 PARALLEL - Constant Current Remote Programming

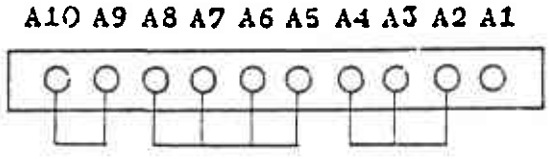
Resistance Programming (0-36V 0-10A)

Read Section 4.7.

Set the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to 5A. Set the maximum required current with No. 2 Current Output control and then switch the power "OFF". Connect the programming resistor and links as shown below.



Programming Resistor



No. 1 Supply

No. 2 Supply Programming Coefficient is equal to approx. 180Ω per Amp.

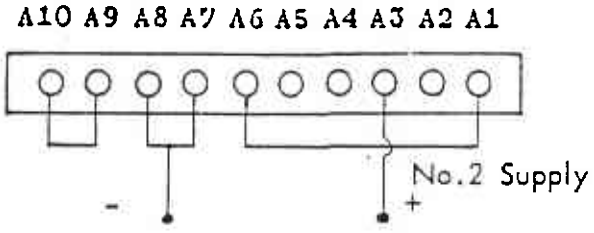
NOTE: DO NOT alter barrier strip connections with unit switched "ON".
See "NOTE":- Section 4.7 using No. 2 SUPPLY ONLY.

4.18 PARALLEL - Constant Current Remote Programming

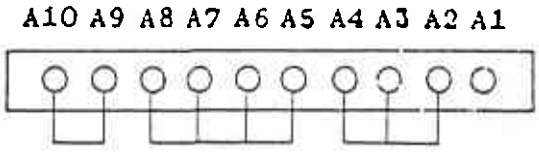
Voltage Programming (0-36V, 0-10A)

Read Section 4.8.

Set the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to 5A. Set the maximum required current with the current output control and then switch the power "OFF". Connect the programming voltage and links as shown below.



Programming Voltage



No. 1 Supply

No. 2 Supply. Programming coefficient is equal to approximately 135mV per Amp.

NOTE: DO NOT alter barrier strip connections with unit switched "ON".

See "NOTE":- Section 4.8 using No. 2 SUPPLY ONLY.

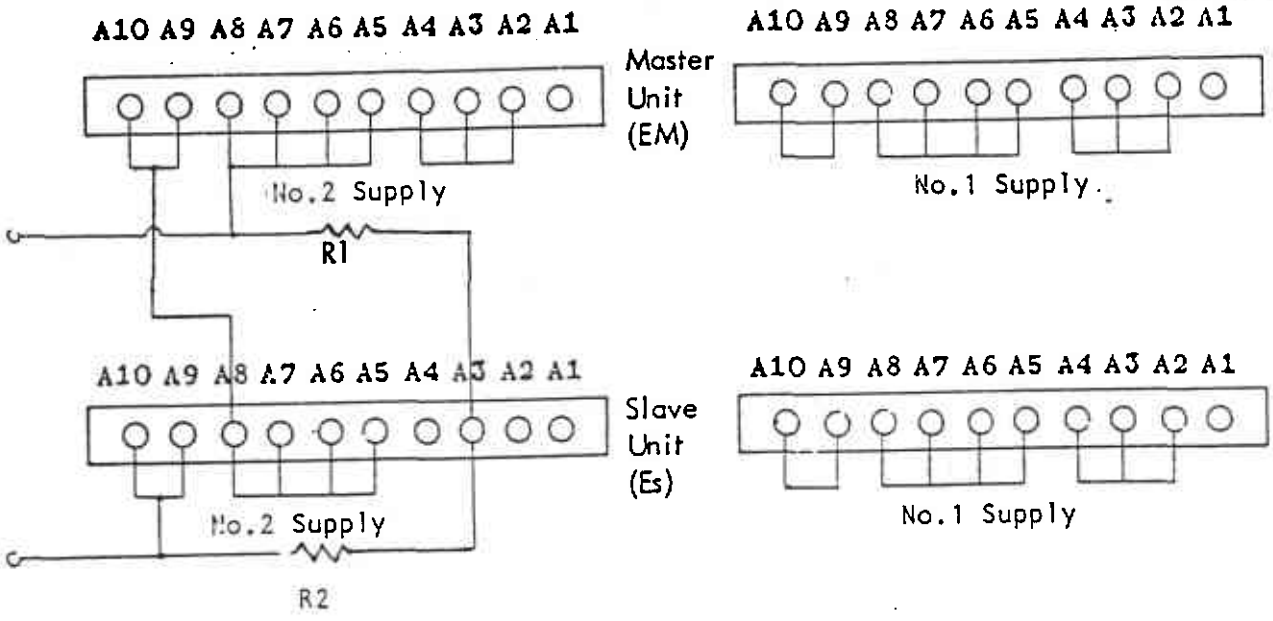
4.19 PARALLEL - Auto Series (0-72V, 0-10A)

Two units both switched to "PARALLEL" may be connected in an automatic series configuration to enable twice the output voltage of the MASTER SUPPLY to be produced. The Auto Series operation is not limited to two units of the same model number, but may be used to connect in series two or more units of differing model number. For list of compatible supplies, see Section 4.32. If another model supply is used, set its front panel controls as indicated for this type of programming in the handbook for that supply.

If using two model BWD 246A supplies set, on BOTH SUPPLIES, the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to 5A. Set the maximum required current with No. 2 current output control on the MASTER UNIT and set the SLAVE current output to MAXIMUM.

For two units in Auto Series connect the rear barrier strip links and resistors as shown overleaf ensuring BOTH UNITS are switched OFF.

4.19 PARALLEL - Auto Series (0-72V, 0-10A) cont'd.



1. IMPORTANT. Use only SINGLE POINT EARTHING.

2. For equal voltages from both supplies
R1 = R2 = 47KΩ.

3. If the SLAVE UNIT is required to vary over a different range than the MASTER UNIT the values of R1 and R2 may be selected.

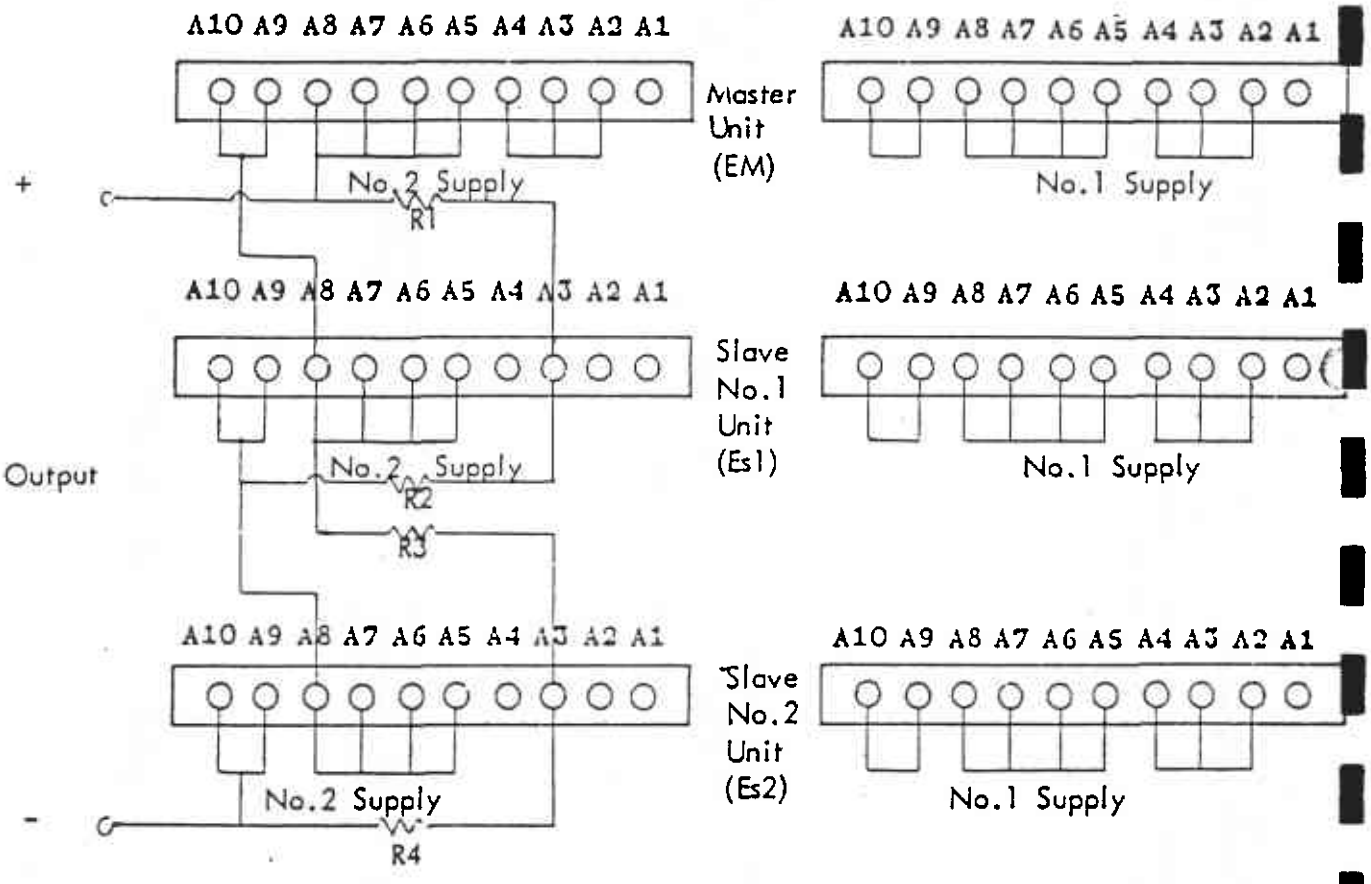
$$\frac{EM}{R_1} = \frac{Es}{R_2}$$ i.e. the ratio of EM to Es is equal to the ratio of R_1 to R_2.

Where EM $\geq$Es and R_1 <50KΩ

4. OPERATION cont'd.

4.19 PARALLEL - Auto Series (0-72V, 0-10A) cont'd.

To connect three units in Auto Series the rear barrier strip links and resistors are connected as shown below with ALL UNITS switched OFF.



4. OPERATION cont'd.

4.19 PARALLEL - Auto Series (0-72V, 0-10A) cont'd.

1. IMPORTANT! Use only SINGLE POINT EARTHING.

2. For equal voltages from all units
$R_1 = R_2 = R_3 = R_4 = 47K\Omega$.

3. If the SLAVE UNITS are required to vary over a different range than the MASTER UNIT the resistor values may be selected.

$$\frac{EM}{R_1} = \frac{Es1}{R_2}$$ Where EM $\geq$Es1 and $R_1 < 50K\Omega$.

$$\frac{Es1}{R_3} = \frac{Es2}{R_4}$$ Where Es1 $\geq$Es2 and $R_3 < 50K\Omega$.

If R2 = R3 we have:-

$$\frac{EM}{R_1} = \frac{Es1}{R_2} = \frac{Es2}{R_4}$$ Where EM $\geq$Es1 $\geq$Es2 and R1 $<50K\Omega$.

NOTE: When using different model power supplies in Auto Series, select the lowest current supply as the MASTER and set the maximum current output of the SLAVE UNITS slightly higher than the MASTER UNIT.

When the supplies are operating in the constant voltage mode any one Ammeter will indicate the total load current plus the external resistive divider current. To monitor the total output voltage all the separate supply voltages may be summarised (by using the individual voltmeters) or an external Voltmeter may be used.

Connect the load between the indicated points and switch "ON" the SLAVE UNITS ONLY. The entire system may be energised by switching the MASTER UNIT "ON".

* * * * *

DO NOT ADJUST THE SLAVE UNITS IN ANY WAY WHILST THE SYSTEM IS OPERATING WITH A LOAD CONNECTED, AS DAMAGE TO THE LOAD MAY RESULT.

* * * * *

The maximum current for each unit is set by the No. 2 current control for that unit. With the load disconnected the terminal switch of each supply may be switched to "SET I" and the maximum current set. Remember to switch ALL units back to USE before commencing to use the supply.

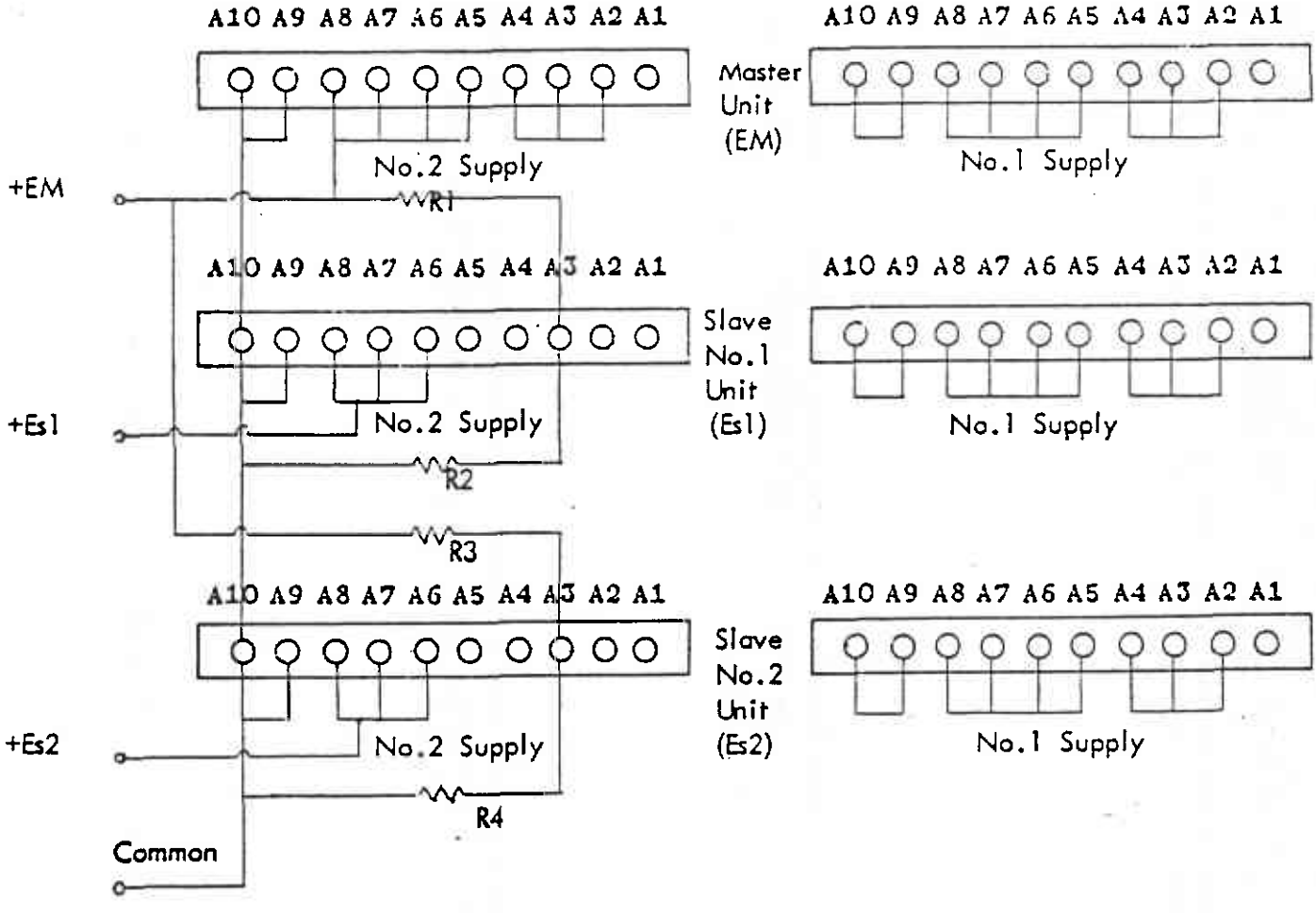
4.20 PARALLEL - Auto-Tracking (2 x 036V, 0-10A)

Several units switched to PARALLEL may be used in the Auto Tracking mode of operation. The rear barrier strip connections for the two basic types of Auto Tracking are shown below. For a description of the system, uses and precautions read Section 4-10. The setting up procedure is identical except for the following items:-

1. Set the function switch, on each supply used, to PARALLEL, all No. 2 terminal switches to "USE", all No. 1 terminal switches to "SET V" and all No. 2 Current Range switches to 5A.

2. Where any controls are referred to in Section 4.10 they shall apply to No. 2 power supply ONLY.

3. Outputs and Inputs shall be applied to No. 2 supply(ies) only.

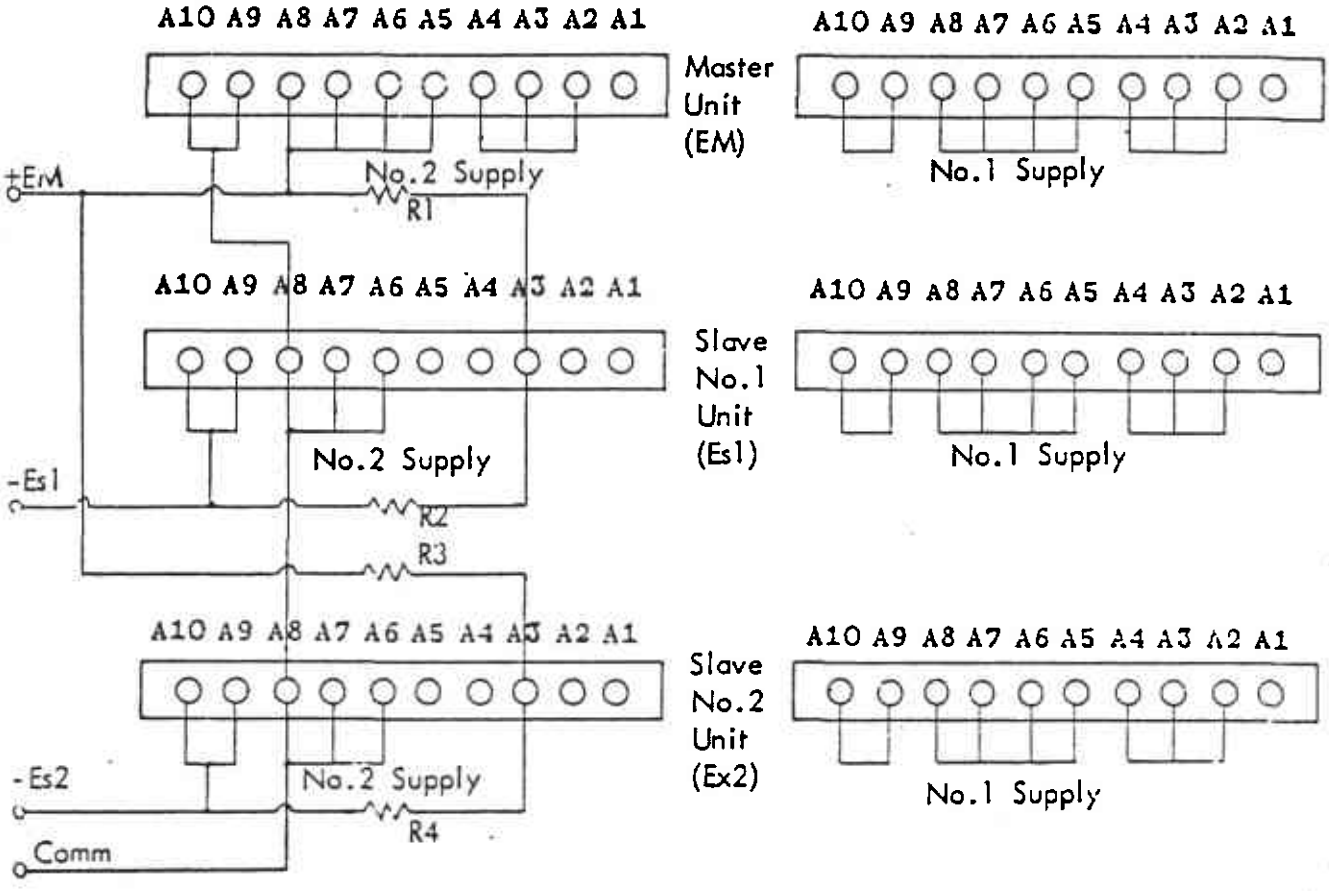


$$Es1 = EM \cdot \frac{R2}{R1 + R2}$$

$$Es2 = EM \cdot \frac{R4}{R3 + R4}$$

NOTE: This configuration may be extended to any number of SLAVE UNITS all using the MASTER UNIT as their programming source.

4.20 PARALLEL - Auto Tracking (2 x 0-36V, 0-10A) cont'd.



$$Es1 = EM \cdot \frac{R2}{R1}$$

$$Es2 = EM \cdot \frac{R4}{R3}$$

NOTE: The magnitude of the SLAVE SUPPLY output may be greater or less than EM depending on the value of the resistors.

This configuration may be extended to any number of SLAVE UNITS all using the MASTER UNIT as their programming source.

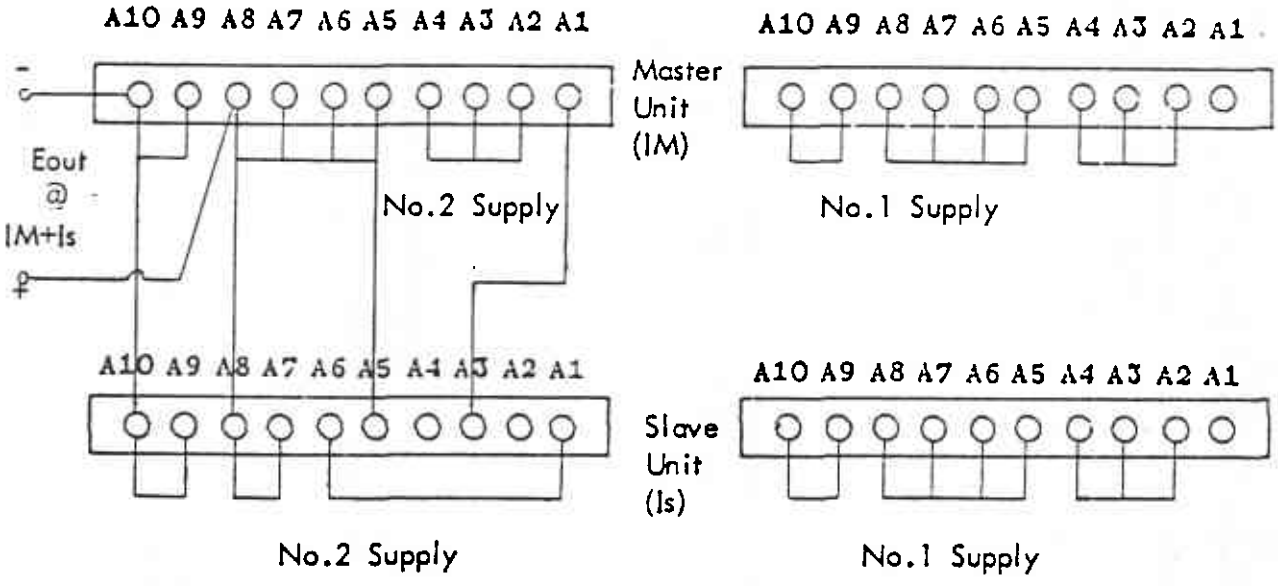
4.21 PARALLEL - Auto Parallel (0-36V, 0-20A)

With several units switched to PARALLEL an Auto Parallel configuration may be used to increase the output current of a single unit. i.e. Two units 20 ampere, three units 30 ampere, etc. The description of the interconnection, uses and precautions can be found in Section 4.11. However, the front panel controls MUST be set up as follows and the interconnection as per the following diagrams. These directions apply to ALL units.

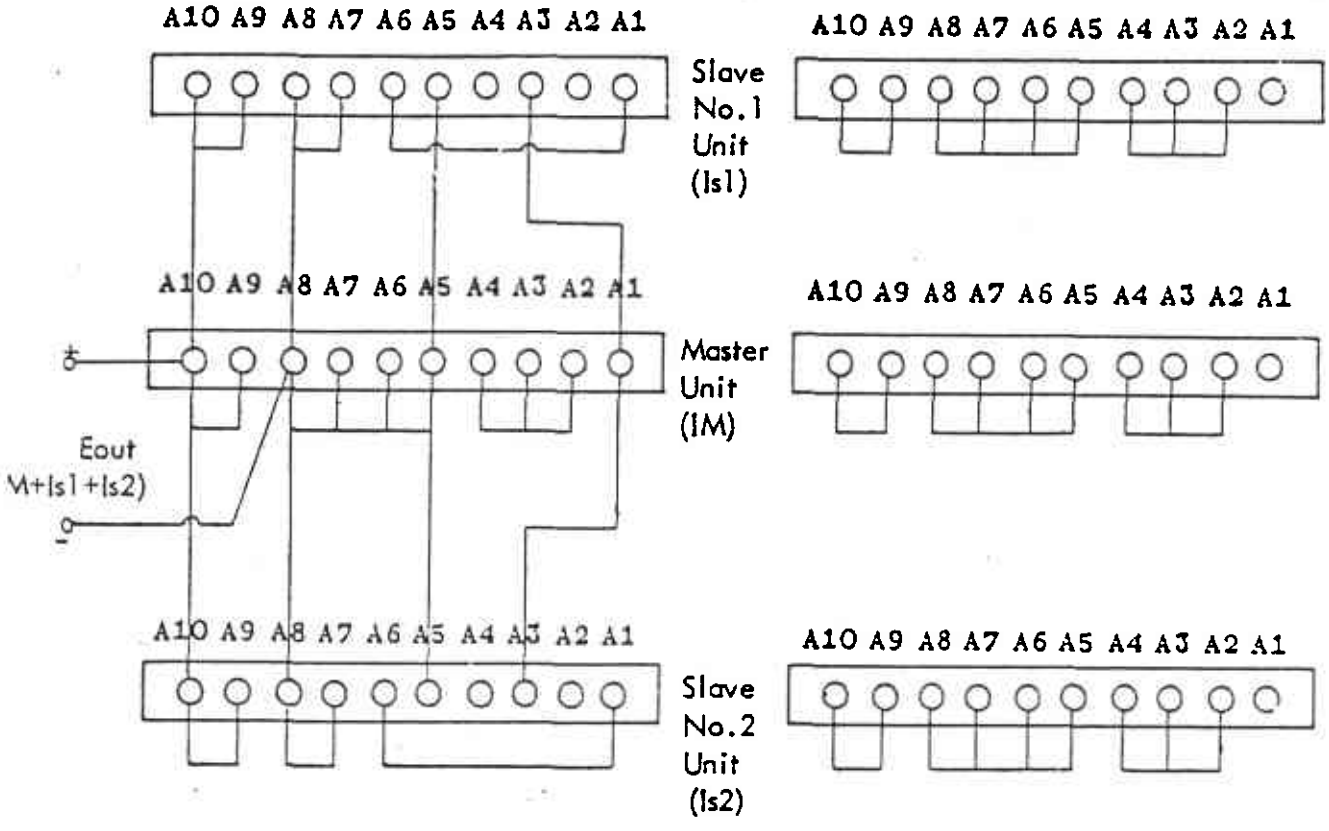
1. Set the function switch to "PARALLEL", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range switch to 5A.

2. Where any controls are referred to in Section 4.11, they shall apply to No. 2 power supply ONLY.

3. Outputs and Inputs shall be applied to No. 2 supply(ie) only.



4.21 PARALLEL - Auto Parallel (0-36V, 0-30A cont'd.

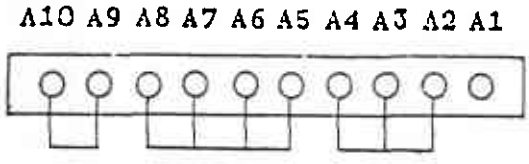


4.22 SERIES - Constant Voltage (0-72V, 0-5A)

Set the function switch to "SERIES", both terminal switches to "SET V" and No. 2 current range to the desired value.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

Check that the rear barrier strips (No. 1 and No. 2) are both wired as shown below and if an alteration is to be made switch the power "OFF".



Switch the power "ON" and set the required output voltage via No. 2 Output Voltage Control and the front panel meter. Switch No. 2 Terminal Switch to "SET 1" and set the required overload current with No. 2 Output Current Control and the front panel meter.

The load may be connected to either No. 2 Output Terminals or A8 (+ve) and A10 (-ve) on the rear barrier strip of No. 2 supply ONLY.

Switch No. 2 terminal switch to "USE".

If the output voltage drops to less than that set earlier, the load is drawing more current than allowed for.

If the load is to be operated at a considerable distance from the power supply and the output impedance required is to be as low as possible, remote load sensing may be employed. See Section 4.24.

4.23 SERIES - Constant Current (0-72V, 0-5A)

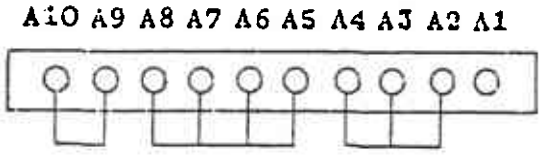
Set the function switch to "SERIES" both terminal switches to "SET V" and No. 2 current range to the desired value.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

Switch the power supply "ON" and set the maximum voltage limit required by the Output Voltage control and the front panel meter. Switch No. 2 terminal switch to "SET 1" and the required output current by the output current control and the front panel meter.

4.23 SERIES - Constant Current (0-72V, 0-5A) cont'd.

Check that the rear barrier strips (No. 1 and No. 2) are both wired as shown below and if an alteration is to be made switch the power switch "OFF".

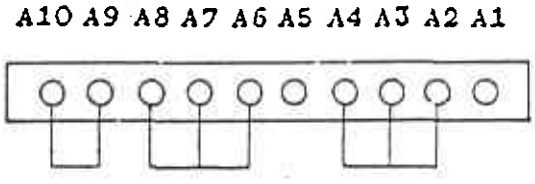


The load may be connected to either the output terminals of No. 2 Supply or A8 (+ve) and A10 (-ve) on the rear barrier strip of No. 2 Supply only.

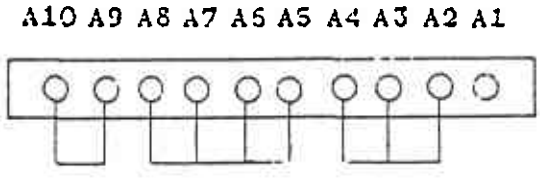
Switch No. 2 terminal switch to "USE".

If the output current is less than that set previously the load impedance is higher than expected. To enable sufficient current to be drawn the upper voltage limit may be increased until correct operation is achieved.

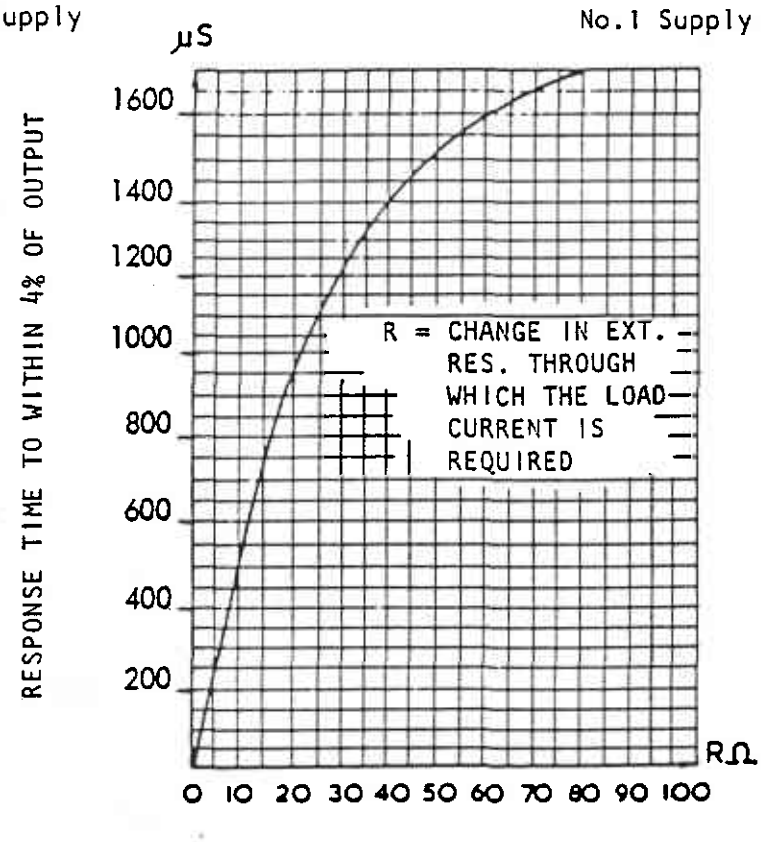
With the rear barrier strip linking above the output capacitance is approximately 2200µF. This high capacity produces a long response time for rapid load changes. To reduce the output capacity the link on No. 2 rear barrier strip joining A5 to A6 (see below) is removed giving a much improved transient response time.



No.2 Supply



No.1 Supply



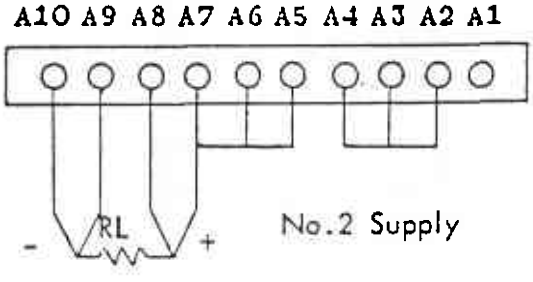
4. OPERATION cont'd.

4.24 SERIES - Remote Load Sensing (0-72V, 0-5A)

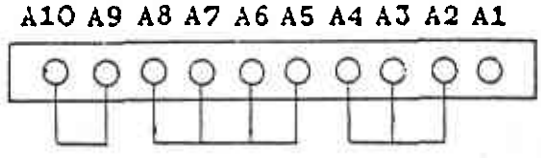
This mode of operation is only required when the supply is used in the Constant Voltage mode and the lead resistance between the load and the power supply is excessive.

Set the function switch to "SERIES", both terminal switches to "SET V" and No. 2 current range to 5A.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply. With the power switch "OFF" connect the load as shown below from No. 2 barrier strip only.



No.2 Supply



No.1 Supply

NOTE: 1. All four leads must have same resistance.

2. To reduce hum pickup, shield all leads or twist together.

The output resistance at the load can be calculated quite closely using the following equation:-

$Ro = 2(2R)^2 \times 10^{-2} + 2 \times 10^{-3}\Omega.$

Where Ro is the output resistance as seen at the load.

And R is the resistance of one lead in Ohms assuming all four leads have identical resistance.

Switch the power switch "ON". If the output voltage drops to less than that set earlier, either the load is drawing excess current or the lead resistance is too high (0.5V max. is a typical figure).

4.25 SERIES - Constant Voltage Remote Programming

Resistance Programming (0-72V, 0-5A)

Set the function switch to "SERIES", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to the desired maximum current.

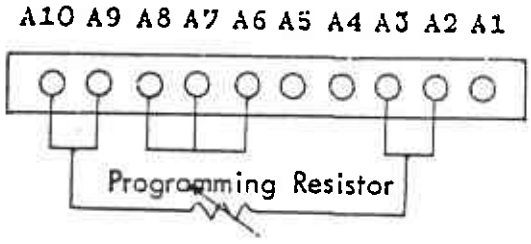
NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

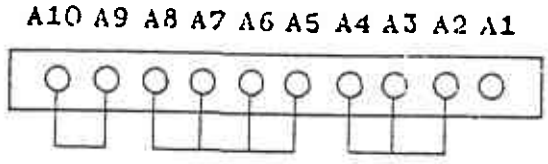
Connect the programming resistor and rear barrier strip links as shown overleaf and take the output from No. 2 output terminals or A8 (+ve) and A10 (-ve) on No. 2 rear barrier strip.

4. OPERATION cont'd.

4.25 SERIES - Constant Voltage Remote Programming cont'd.

Resistance Programming (0-72V, 0-5A) cont'd.





Programming coefficient is equal to approximately 1.3K per Volt.

NOTE: DO NOT alter barrier strip connections with unit switched "ON". See "NOTE":- Section 4.5 using No. 2 SUPPLY ONLY.

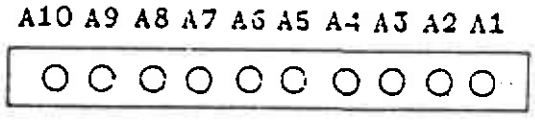
4.26 SERIES - Constant Voltage Remote Programming

Voltage Programming (0-72V, 0-5A)

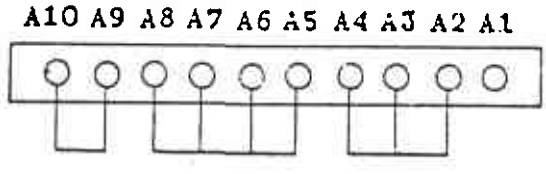
Set the function switch to "SERIES", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to the desired value.

NOTE: Any front panel controls not mentioned may be left in any position without having any effect on the performance of the supply.

With the power switch "OFF" connect the rear barrier strip as shown below and take the output from the No. 2 output terminals or A8 (+ve) and A10 (-ve) on No. 2 rear barrier strip.



See Section 4.6 for connection of No. 2 Supply



No. 1 Supply

All of the three types of voltage programming described in Section 4.6 are applicable to SERIES operation.

USE ONLY NO. 2 CONTROLS AND CONNECTIONS

See "NOTE":- Section 4.6.

4.27 SERIES - Constant Current Remote Programming

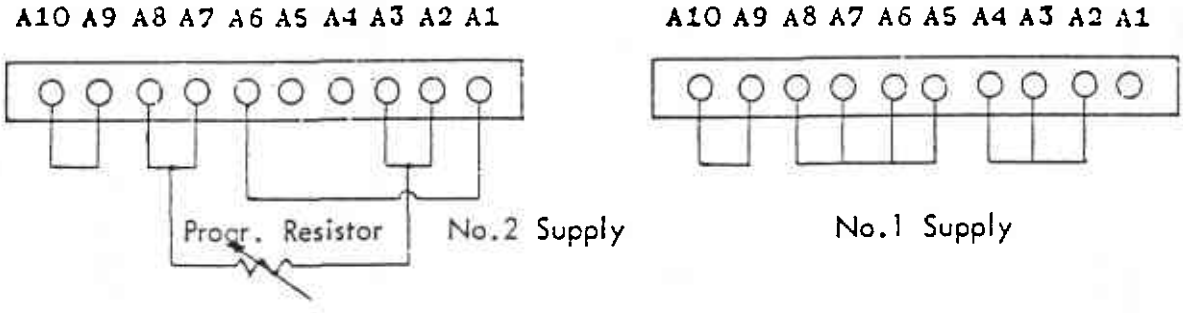
Resistance Programming (0-72V, 0-5A)

Read Section 4.7.

Set the function switch to "SERIES", No. 1 terminal switch to "SET V", No. 2 terminal switch to "USE" and No. 2 current range to the desired current range.

Set the maximum required current with No. 2 current output control and then switch the power "OFF".

Connect the programming resistor and links as shown below.



Programming Coefficient is equal to approx. 340Ω per amp.

NOTE: DO NOT alter barrier strip connections with unit switched "ON".

See "NOTE":- Section 4.7 using No. 2 SUPPLY only.

4.28 SERIES - Constant Current Remote Programming

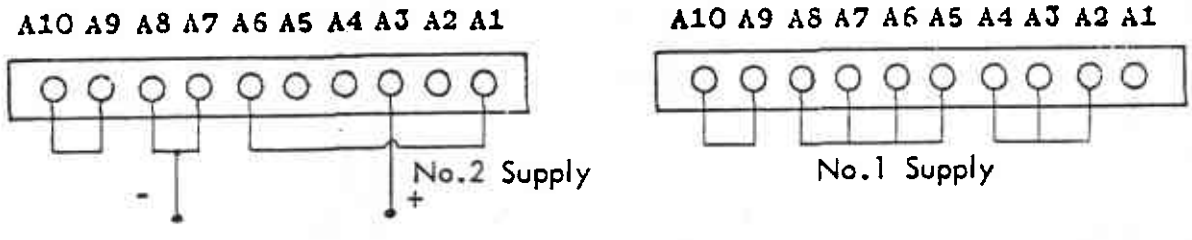
Voltage Programming (0-5A, 0-72V)

Read Section 4.8

Set the function switch to "SERIES", No. 2 terminal switch to "USE", No. 1 terminal switch to "SET V" and No. 2 current range to the desired current range.

Set the maximum required current with No. 2 current output control and then switch the power "OFF".

Connect the programming voltage and links as shown below.



Programming Voltage

Programming Coefficient is equal to approx. 235mV per Amp.

NOTE: DO NOT alter barrier strip connections with unit switched "ON".

See "NOTE":- Section 4.8 using No. 2 SUPPLY ONLY.

4.29 SERIES - Auto Series (0-144V, 0-5A)

Two units both switched to "SERIES" may be connected in an automatic series configuration to enable twice the output voltage of the MASTER SUPPLY to be produced. The auto series operation is not limited to two units of the same model number, but may be used to connect in series two or more units of differing model number. For list of compatible supplies see Section 4.32. If another model supply is used, set its front panel controls as indicated for this type of programming in the handbook for that supply.

If using two model 246A supplies, set, on BOTH SUPPLIES, the function switch to "SERIES", No. 1 Terminal Switch to "SET V", No. 2 Terminal Switch to "USE" and No. 2 Current Range to the desired current range. Set the maximum required current with No. 2 Current Output Control ensuring that the MASTER SUPPLY is set for the lowest current of all the supplies in auto series. Switch the power "OFF" and connect the rear barrier strip links and resistors as shown in Section 4.19.

For full description of both two and three unit auto series connection ALL information after and including the diagram for *two units in Auto Series* Section 4.19, to the end of Section 4.19, is directly applicable.

4.30 SERIES - Auto Tracking (2 x 0-72V 0-5A)

Several units switched to "SERIES" may be used in the Auto-Tracking mode of operation. The rear barrier strip connections for the two basic types of Auto-Tracking are shown in Section 4.20. For a description of the system, uses and precautions read Section 4.20. The setting up procedure is identical except for the following items.

Set the function switch on each supply used to "SERIES", all No. 1 Terminal Switches to "SET V", all No. 2 Terminal Switches to "USE" and all No. 2 Current Range Switches to 5A. Set all SLAVE UNIT current controls to max. clockwise and set the MASTER UNIT No. 2 Current Control to the required maximum output current for that supply (if required, each SLAVE UNIT output current may be set to a specific value depending on the load requirements).

4.31 SERIES - Auto Parallel (0-72V, 0-10A)

With several units switched to "SERIES" an auto-parallel configuration may be used to increase the output current of a single unit, i.e. two units 10 ampere, etc. The description of the interconnection, used, precautions and connection diagrams can be found in Section 4.21. However all the front panel controls must be set up as follows.

Set the function switch to "SERIES", No. 1 Terminal Switch to "SET V", No. 2 Terminal Switch to USE and No. 2 Current Range Switch to 5A.

4.32 COMPATIBLE SUPPLIES THAT MAY BE USED WITH MODEL BWD 246A IN REMOTE PROGRAMMING MODES

BWD 242A Identical operation to BWD 246A except ratings are lower:

36V @ 2A + 36V @ 2A

BWD 272A Single supply with three switched ranges:

0 - 12V @ 2A
0 - 25V @ 1A
0 - 50V @ 0.5A

BWD 275 Single supply with two switched ranges:

0 - 36V @ 2A
0 - 72V @ 1A

5. CIRCUIT DESCRIPTION

5.1 Model BWD 246A is a dual supply, the two halves of which are practically identical except for various frequency compensating networks. The following circuit description is based around the No. 2 supply switched to the INDEPENDENT mode. From the circuit diagram at the rear of the book it can be seen that the circuit layout is almost identical so that equivalent components in No. 1 supply may easily be found once located on No. 2 circuit.

5.2 The power supply, (refer Figure 1), consists of two rectifier-filter circuits; one supplying the auxiliary supply, the other supplying the series regulator and, via the current sensing resistor, the output. The voltage developed across the current sensing resistor is the input to the constant current circuit. The output voltage of the supply is sampled by the voltage input amplifier via the sensing leads, compared against the voltage across the voltage control and any changes amplified and fed to the OR gate. The constant current circuit also feeds into the OR gate. Any changes required are amplified and applied to the series regulator in the correct phase and amplitude to correct the output. The auxiliary supply is used throughout the circuit to provide DC power to the amplifier and a stable voltage where comparison is necessary.

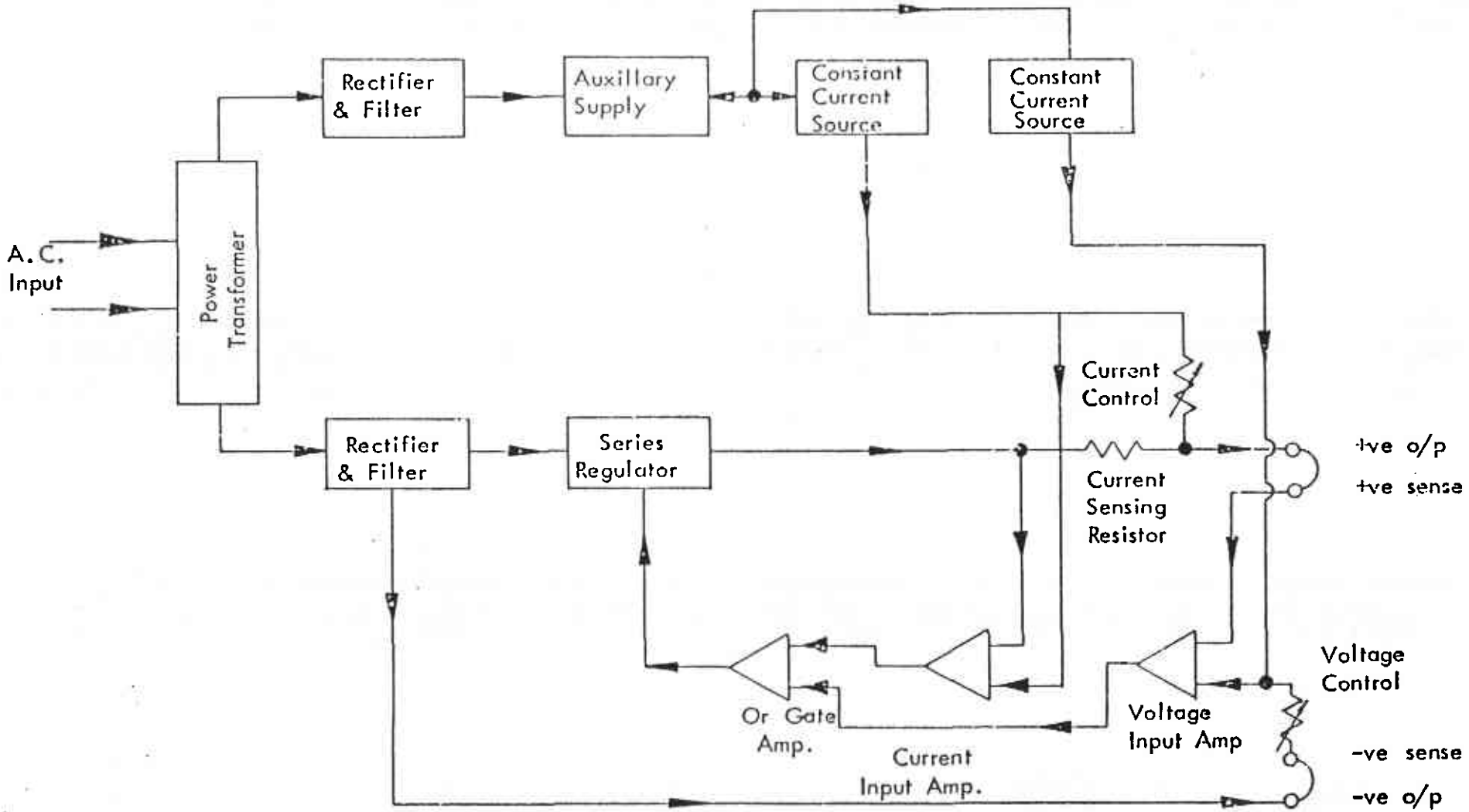
5.3 Power transformer T1 has two main secondary windings, 0-30V, 0-49V. The 0-30V winding is rectified by D1 filtered by C1 and regulated by Q15, 16 and 17 to provide a +16V auxiliary supply with reference to the +ve output. The reference voltage to Q17 is supplied by D2 which also provides a -6V supply. The 0-49V winding is bridge rectified by DR1, and filtered by C15.

Series regulator Q13, Q14 is driven by emitter follower Q9, which is in turn driven via D24, D25 and D30 by Q7 and Q18.

5.4 Transistors Q8 and Q11 & Q12 form a pre-regulator. When the voltage across Q13 and Q14 is greater than 1V, Q8 and Q11 & Q12 are cut off and the output current flows via R75, R76 & R77 to Q13 & Q14. As the current and hence the voltage drop across R75, R76 & R77 increase, the voltage across Q1A & Q1B will drop to a value lower than 1V. Q8 will conduct causing Q11 & Q12 to conduct and maintain a minimum voltage across Q13 and Q14 under all conditions.

5.5 The +ve output is taken from A8 to A7 where it becomes the +ve sensing line. The rear terminal strip link between A2 and A3 takes the +ve sensing line to pin 6 of IC2B via R21. Referring to the Integrated Circuit schematic, the +ve sensing is taken to Q5 base. Q6 base (pin 9) is taken via R18 to A5 which is linked externally to A4 and A6. A6 is connected to RV1, the Output Voltage Control, the other end being connected to the -ve sensing line via S6A and S4B. A constant current source provided by Q20, R20 and RV5 is taken to A4, and this current through RV1 sets the base voltage of Q6. Balance in the differential pair (Q5, Q6) will occur when the +ve sensing voltage is equal to the voltage across RV1. The output of IC2B is taken from the collector of Q5 via D4 to emitter follower Q18.

Figure 1 BLOCK DIAGRAM



5.5 cont'd.

An increase in the value of RV1 will cause the base of Q6 to rise in a positive direction. Q6 emitter and hence Q5 emitter will also rise tending to reduce conduction in Q5. Q5 collector will also rise and via D4, Q18 and the series regulator circuit the output voltage will also rise until the bases of Q5 and Q6 are at an equal potential. Any changes in the output voltage not caused by RV1 will appear on the base of Q5 which will invert and amplify the change and via D4, Q18 and the regulator circuit correct the output.

5.6 The current sensing resistor R16 develops a voltage across itself proportional to the output current. The base of Q1 (IC2A) is connected to the input of R16 via R15 so that the base of Q1 will increase its potential in a positive direction as the output current increases. The base of Q2 is taken via R80 to the positive end of RV3, the Output Current Control. Constant current source Q19, R10 and RV7 feeds into RV3 producing a voltage at Q2 base which is proportional to the value of RV3.

When the output current rises such that the base of Q1 rises above the base potential of Q2, Q1 increases its conduction and via D3 and Q18 reduces the output of the supply. A quiescent level of output is reached when the bases of Q1 and Q2 are at an equal potential.

5.7 The output impedance compensation networks introduce positive feedback into their respective amplifiers to achieve an easily adjustable output characteristic. RV11 connected across the current sensing resistor R16 produces a voltage at its wiper which is proportional to the output current and increases in a positive direction as the current increases. This voltage is fed via R25 into pin 12 of IC2B (emitter Q4). As the emitter of Q4 goes positive the collector of Q4 and hence the emitters of Q5 and Q6 will go positive. Q5 will reduce its conduction and via D4, Q18 and the Series Regulator, increase the output voltage. The amount of feedback can be varied by adjusting RV11 to produce a range of output impedance either side of zero.

The Constant Current output impedance feedback voltage is derived from the positive end of RV1 the Output Voltage Control. In constant voltage operation this voltage always stays at zero volts with respect to the positive output line. However, as the constant current circuit comes into operation the output voltage will be lower than that of the output voltage control. D6 will conduct and the wiper of RV14 will pick up a positive potential which via R17 will increase the conduction of Q1 (IC2A) and reduce the output current as the output voltage decreases in the constant current mode the output current will tend to increase. Adjustment of RV14 will correct for this producing a range of control either side of infinite output impedance.

5.8 The Series, Independent, Parallel switch (S6) is shown on the circuit diagram in the Parallel position. The functions of each section are listed below:-

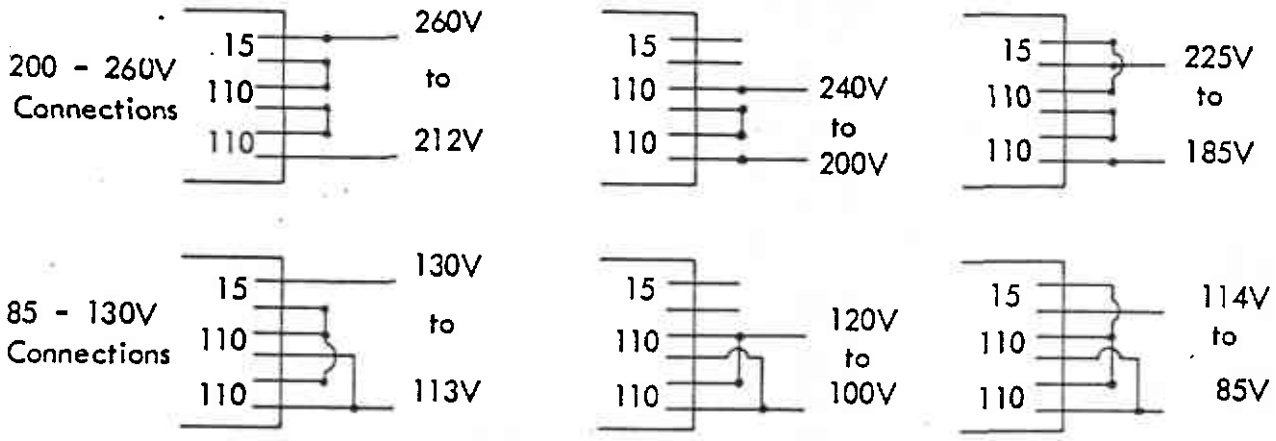


Figure 2. TRANSFORMER CONNECTIONS

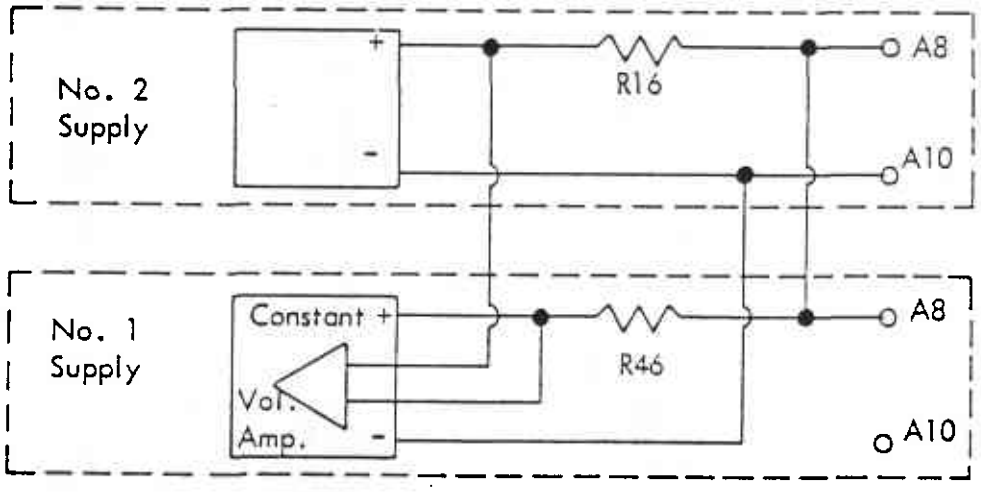


Figure 3. PARALLEL CONNECTIONS

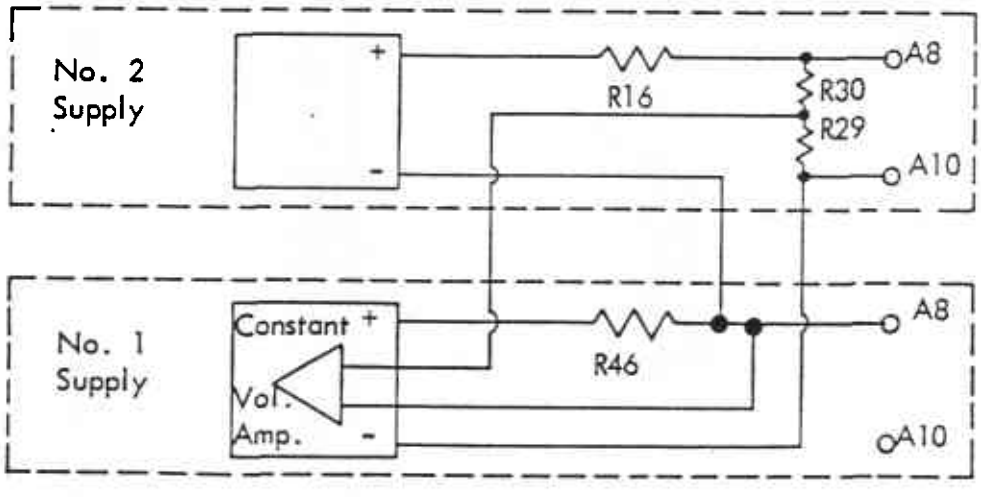


Figure 4. SERIES CONNECTIONS

5.8 cont'd.

S6A in Independent and Parallel connects the bottom end of RV1, the output voltage control to the negative sensing terminal of No. 2 supply. In Series RV1 is connected to the centre tap of the two supplies.

S6B switches either RV11 (in Parallel or Independent) or RV12 (in Series) into the constant voltage output impedance feedback network, providing separate adjustment for Series operation.

S6C connects the negative output of No. 2 Supply to either its own -ve output terminal or the +ve output of No. 1 Supply.

S6D, E select the points to which the inputs of the Constant Voltage amplifier, No. 1 Supply, are taken to for the three modes of operation.

S6F performs two functions, the first being to disable the constant current control on No. 1 Supply for Series and Parallel operation, and the second to connect the two +ve outputs together in Parallel operation.

S6G connects the -ve output (No. 1) to its own output terminals in Independent. In Series and Parallel the -ve output is taken to the -ve output terminals of No. 2 Supply.

S6H switches the negative end of the Voltmeter circuit to the appropriate points when S6 is operated.

For connection diagrams of the supplies when in Parallel and Series see Figure 3 and Figure 4 respectively.

5.9 The Ammeter and Voltmeter switching enables either voltage or current measurements to be made on either supply completely independently. The Ammeter Selector S8A & B selects either No.1 or No.2 Supply for current metering. For No.1 Supply the current sensing resistor is R46 and two preset controls RV18 and RV19 are switched by S3B to provide 0-500mA and 0-5A meter ranges. When the unit is switched to Series the output current flows through both current sensing resistors so that the position of S8 will not vary the meter reading.

NOTE: If the centre tap of the supply is used to provide current output, there will be a different current in each supply which will be shown on the ammeter. Since the currents are balanced equally between the two supplies in Parallel mode the operation of S8 will not affect the reading appreciably. For more accurate measurement of current in parallel, the meter readings may be added together to provide the total current.

The Voltmeter switching is essentially identical to the Ammeter switching since in Series and Parallel the output voltages of the two supplies are identical resulting in no appreciable difference in meter reading when S7 is operated.

5.10 The "Set I, Set V, Use" switch - S4A & B for No. 2, S5A & B for No. 1 - disconnects the negative output terminal and negative sensing circuit when in the Use position enabling the output voltage to be set internally. In the "Set I" position the supply is internally shorted via R28 (No.2) or R58 (No.1) enabling the output current to be set whilst maintaining the voltage at the output terminals at zero.

5.11 The AC input to the supply is taken via S1A and S1B and a 5A Delay fuse to the two transformers T1 and T2 whose primary windings are connected in parallel across the supply. Interconnection of the voltage tappings on the primary windings give a wide range of input voltages, see Figure 2.

6. ALIGNMENT

Component changes will not normally affect the performance of the supply, subject to the replacement component being of similar size stability and performance to the original component.

6.1 Test Instruments Required

Type	Characteristics	Use
DC Voltmeter	At least 0-40V and 0-80V 1% accuracy	Voltage Check (meter cal)
DC Ammeter	0-500mA, 0-5A and 0-10A ranges 1% accuracy	Current Check (meter cal)
DC Millivoltmeter	Max. sensitivity at least 1mV FSD	Output Z Measurement
DC Bucking Supply	0V to >72V	

6.2 RV5 Maximum Voltage Preset No. 2 Supply

Switch the supply to *Independent* and set the No. 2 Output Voltage Control to max. clockwise. Adjust RV5 to give 36.5V across the output terminals.

6.3 RV6 Maximum Voltage Preset No. 1 Supply

Adjust as for RV5 using No. 1 output terminals and Voltage Control.

6.4 RV7 Maximum Current Preset 5A No. 2 Supply

Switch the supply to Independent and set the No. 2 Output Current Control to max. clockwise. Adjust RV7 with an external ammeter connected across the output terminals so that the maximum current lies within the range 5.2A to 5.5A.
NOTE: Range Switch in 5A position.

6.5 RV8 Maximum Current Preset 500mA No. 2 Supply

Adjust RV8 in the same manner as RV7 ensuring that the range switch is in the 0.5A position and the maximum current range is 610mA to 650mA.

6.6 RV9 Maximum Current Preset 5A No. 1 Supply

Adjust as for RV7 using No. 1 controls and terminals.

6.7 RV10 Maximum Current Preset 500mA No. 1 Supply

Adjust as for RV8 using No. 1 controls and terminals.

6.8 RV11 Constant Voltage Output Impedance Preset No. 2 Supply

RV11 is adjusted so that when a 0-5A load change is applied to No. 2 Supply, the change in output voltage is less than 5mV. Should a large change occur, check that the Constant Current is set to greater than 5.1A. See Figure 5 for measurement of Δ V.

6.9 RV12 Constant Voltage Output Impedance Preset Series

RV12 is adjusted in the manner as RV11 ensuring that the Supply is switched to SERIES and No. 2 output terminals are used.

6.10 RV13 Constant Voltage Output Impedance Preset No. 1 Supply

Adjust as for RV11 using No. 1 terminals and controls with the Supply switched to INDEPENDENT.

6. ALIGNMENT cont'd.

6.11 RV14 Constant Current Output Impedance Preset No.2 Supply

With the Supply switched to INDEPENDENT and a load across the terminals drawing 5A at 36V the Current Output Control is adjusted to give 30V output. Placing a short circuit across the load resistor should result in a current increase of less than 0.3mA. Adjust RV14 to produce less than 0.3mA increase.

NOTE: Current monitoring can be done using a small series resistor which is not shorted out and the measurement technique for Δ V Section 6.8.

6.12 RV15 Constant Current Output Impedance Preset No.1 Supply

Adjust as for RV14 using No.1 terminals and controls with the Supply switched to INDEPENDENT.

6.13 RV16 Ammeter Calibrate Preset 5A No.2 Supply

Switch the Supply to INDEPENDENT and the No.2 Current Range Switch to 5A. Connect a 5A Ammeter across the supply and adjust the Output Current Control until the external ammeter reads 5.0A. Adjust RV16 for the front panel ammeter to read 5.0A.

NOTE: Check before and after the adjustment that the mechanical zero of the meter is set correctly.

6.14 RV17 Ammeter Calibrate Preset 500mA No.2 Supply

Adjust as for RV16 ensuring that the Current Range Switch is set to 0.5A and use a 0.5A Ammeter.

6.15 RV18 Ammeter Calibrate Preset 5A No.1 Supply

Adjust as for RV16 using No. 1 terminals and controls with the supply switched to INDEPENDENT.

6.16 RV19 Ammeter Calibrate Preset 500mA No.1 Supply

Adjust as for RV17 using No.1 terminals and controls with the Supply switched to INDEPENDENT.

6.17 RV22 Crowbar Overvoltage Range Preset No.2 Supply

See Section 9. Option 08.

6.18 RV23 Crowbar Overvoltage Range Preset No. 1 Supply

See Section 9. Option 08. (Crowbar overload normally fitted)

6.19 RV24 Minimum Current Preset No.2 Supply

Switch the supply to Independent and set the No.2 Output Current Control to minimum output. Adjust RV24 with an external ammeter connected across the output terminals so that the output current is less than 10mA, typically 5mA. Check the output current with the Current Range switch in both positions adjusting RV24 for less than 10mA in both positions.

6. ALIGNMENT cont'd.

6.20 RV25 Minimum Current Preset No. 1 Supply

Set RV25 using the same procedure as RV24 ensuring only No.1 terminals and controls are used.

6.21 RV26 Voltmeter Calibrate Preset

Switch the supply to Parallel and set the output voltage using an external voltmeter to 36.0V. RV26 is then set so that the front panel voltmeter reads FSD. A compromise may be necessary when the Meter Selector is varied to obtain optimum accuracy.

7. MAINTENANCE

7.1 Removal of Covers

a. Remove the Eight (8) screws retaining the handle and covers.

b. Remove the four large screws and one small screw from each side of the unit.

c. The top cover may now be removed.

d. With unit inverted remove the two screws in the runners.

e. The bottom cover may now be removed.

f. Remove the four small screws at each corner of the rear perforated heatsink cover. Remove the two large screws near the centre of the cover and withdraw cover from heatsink assembly.

7.2 Removal of Heatsink

a. Two heatsinks are mounted together on a backing plate which can be removed by unscrewing the two screws situated at the top and bottom of the backing plate.

b. Removal of the two ¼" WHIT. screws on each heatsink will release the heatsink from the backing plate.

7.3 Semiconductor Replacement

Before removing any transistors from the power supply the transistor should be labelled so that in the event a defective transistor is found its circuit location may be identified thus isolating the source of trouble.

Should it be necessary to remove a matched pair of transistors ensure that they are returned to the same point. DO NOT replace one of a matched pair, replace only with a pair obtained from the manufacturer: See Section 8.

8. REPLACEMENT PARTS

Spares are normally available from the manufacturer, BWD Instruments Pty. Ltd. When ordering, it is necessary to indicate the model and serial number of the instrument. If exact replacements are not to hand, locally available alternatives may be used, provided they possess a specification not less than, or physical size not greater than the original components.

As the policy of BWD Instruments Pty. Ltd. is one of continuing research and development, the Company reserves the right to supply the latest equipment and make amendments to circuits and parts without notice.

9. OPTIONS (Description, Use and Alignment)

9.1 Option 02 - Digit Dial for Ten Turn Voltage Control

The setting of Maximum Voltage presets (RV5 and RV6) remain the same except that a different maximum voltage, i.e. 36V or 37V may be chosen so that interpolation of the dial indication against output voltage may be easier. Once the voltage has been set a multiplier of the dial reading can be established to facilitate accurate setting of the output without requiring a voltmeter.

9.2 Option 03 - 10 Turn Current Control with Digit Dial

This option may be fitted to either or both current controls resulting in a resolution of 150µA for the 500mA and 1.5mA for the 5A range.

The setting of Maximum Current presets (RV7, RV8, RV9 and RV10) remain the same. However, for convenience of producing a single logging scale RV7 and RV9 should be set to exactly ten (10) times the value of RV8 and RV10.

9.3 Option 05 - 10 Turn Voltage Control (No Digit Dial)

The control fitted for this option is identical to that fitted in Option 02, but without a digit dial indicator. Adjustment of RV5 and RV6 is the same as detailed in Section 6.2 and 6.3 respectively. Resolution is equal to 6mV.

9.4 Option 06 - 10 Turn Current Control (No Digit Dial)

The control fitted for this option is identical to that fitted in Option 03, but without a digit dial indicator. Adjustment of RV7, RV8, RV9 and RV10 is the same as detailed in Section 6. Resolution is equal to 150µA for the 500mA range and 1.5mA for the 5A range.

9.5 Option 08 - Crowbar Overvoltage Overload

Option 08 when fitted to a supply provides an overvoltage protection. When an overvoltage condition exists a silicon controlled rectifier places a short circuit across the output which will remain until the overload is reset.

The circuit of the crowbar overload can be seen on the main circuit drawing and is shown connected directly across the output terminals. The overload circuit of No.2 supply will be described since the operation of both circuits is identical.

SCR1 silicon controlled rectifier is connected directly across the output of No.2 Supply. The gate of SCR1 is driven via S10A by the two transistors Q27 and Q28 which form a simulated regenerative SCR with its gate, the base of Q28, connected to a voltage divider consisting of R63, RV22 and RV20 which senses the output voltage.

9. OPTIONS (Description, Use and Alignment) cont'd.

9.5 cont'd.

S10A & B, on the rear of RV20 overvoltage control, function as an ON-OFF control by:

a. Removing the drive circuit from the gate of SCR1 and

b. Open circuiting the overvoltage control thus preventing input signals to Q28.

RV22 (or RV23) is set in the following manner:-

Turn the Crowbar Overvoltage control to max. clockwise and then back off by approximately 20°. Set the Output Voltage of the particular supply to zero and switch the unit "ON". Set the terminal switch to "USE" and slowly increase the output voltage noting where the overload trips.

RV22 is adjusted so that in the SERIES mode the trip voltage is 72V. RV23 is adjusted so that in the INDEPENDENT mode the trip voltage is 36V. The setting of RV22 (or RV23) may take several attempts since once the overload has been operated the output voltage must be:

a. Reduced to zero to reset the crowbar overload and then

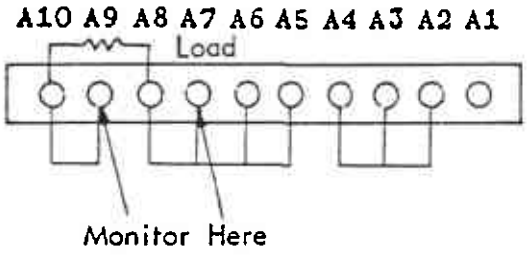
b. Increased slowly after RV22 (or RV23) has been adjusted to obtain the correct trip point.

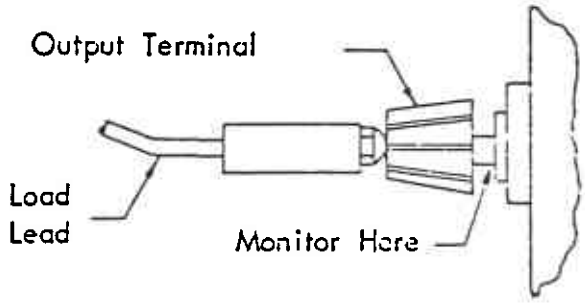
NOTE: Should an internal malfunction of the Series Regulator occur which attempts to increase the output voltage above the trip point, the Crowbar Overvoltage control will operate and blow either the internal DC fuse or the front panel mounting AC fuse.

10. GUARANTEE

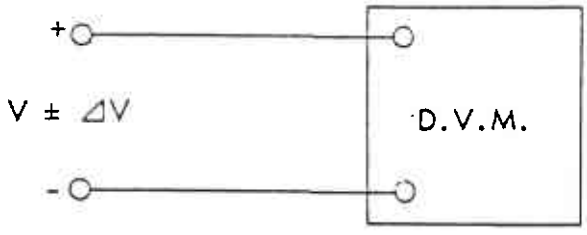
The equipment is guaranteed for a period of twelve (12) months from the date of purchase against faulty materials and workmanship.

Please refer to Guarantee Registration Card No. ..... which accompanied instrument for full details of conditions of warranty.





D.V.M. must have adequate resolution to measure V ± ⊿V



Adjust DC Supply to offset V

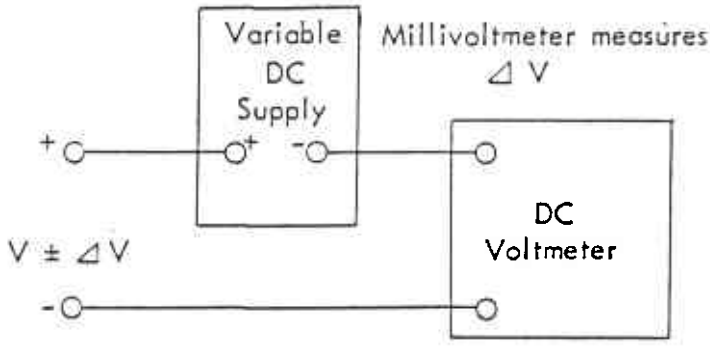


Figure 5: MEASUREMENT OF ⊿ V

REPLACEABLE PARTS

1. This section contains information for ordering replacement parts. It provides the following details.

   a. Description of part (see List of Abbreviations)
   b. Typical manufacturer or supplier of the part (see list of abbreviations)
   c. Manufacturer's Part Number; and
   d. Defence Stock Number, where applicable.

2. Ordering - Please quote Model Type No., e.g. BWD 539C Serial No. Circuit Reference No. and component details as listed in parts list.

COMPONENT DESIGNATORS

A	Assembly	H	Heater	RV	Resistor Variable
B	Lamp	J	Jack (socket)	S	Switch
C	Capacitor	L	Inductor	T	Transformer
D	Diode	M	Meter	TH	Thermistor
DL	Delay Line	P	Plug	V	Valve
E	Misc.Elect.Part	Q	Transistor	VDR	Voltage Dependent Resistor
F	Fuse	R	Resistor		

ABBREVIATIONS

Amp	Ampere	L	Inductor
C	Capacitor	lin	Linear
cc	Cracked Carbon	Log	Logarithmic Taper
c	Carbon	m	Milli = 10^{-3}
cd	Deposited Carbon	MHz	Mega Hertz = 10^{6}Hz
comp	Composition	MF	Metal Film
CDS	Ceramic Disc Capacitor	ma	Milli Ampere
cer	ceramic	MΩ	Meg Ohm = $10^{6}\Omega$
Coml	Common	mfr	Manufacturer
DPST	Double Pole Single Throw	MO	Metal Oxide
DPDT	Double Pole Double Throw	MHT	Polyester/Paper Capacitor
ELECTR	Electrolytic	MPC	Metalised Polyester Capacitor
F	Farad	Ne	Neon
f	Fuse	NPO	Zero temperature coefficient
FET	Field Effect Transistor	nsr	Not separately replaceable
Ge	Germanium	NC	Normally Closed
H	Henry(ies)	NO	Normally Open
H.S.	High Stability	ns	Nano second
HTC	High Temp Coating	obd	Order by Description
ins	Insulated	OD	Outside Diameter
kHz	Kilo Hertz = 10^{3}Hz	p	Peak
KΩ	Kilo Ohm = $10^{3}\Omega$	pf	pico farad = 10^{-12}F

COMPONENT ABBREVIATIONS cont'd.

PL	Plug
PS	Socket .
Preset	Internal Preset
PYE	Polyester
pot	Potentiometer
prec	Precision
PC	Printed circuit
PIV	Peak Inverse Voltage
PYS	Polystyrene
p-p	Peak to Peak
P.Shaft	Plain Shaft
Q	Transistor
R	Resistor
rot	Rotary
R log	Reverse Logarithmic Taper
rms	Root Mean Squared
SM	Silver Mica
SPDT	Single Pole Double Throw
SPST	Single Pole Single Throw
S.Shaft	Slotted Shaft
Si	Silicon
Ta	Tantalum
tol	Tolerance
trim	Trimmer
V	Volt(s)
var	Variable
vdcw	Volts Direct Current Working
w	Watt(s)
ww	Wire Wound
Z	Zener
*	Factory Selected value, nominal value may be shown
**	Special component, no Part No. assigned

MANUFACTURERS ABBREVIATIONS

AB	A.B. Electronics
AEE	AEE Capacitors
AC	Allied Capacitors
AST	Astronic Imports
AWA	Amalgamated Wireless of Aust.
ACM	Acme Engineering Pty. Ltd.
AMP	Aircraft Marine Products (Aust) Pty. Ltd.
AR	A & R Transformers
AUS	Australux Fuses
AWV	Amalgamated Wireless Valve Co.
ACA	Amplifier Co. of Aust.
ARR	Arrow
BWD	BWD Instruments Pty. Ltd.
BL	Belling & Lee Pty. Ltd.
BR	Brentware (Vic.) Pty. Ltd.
BU	Bulgin
CF	Carr Fastener
CAN	Cannon Electrics Pty. Ltd.
CIN	Cinch
DAR	Darstan
DIS	Distributors Corporation P/L
ELN	Elna Capacitors (Sonar Elec. P/L)
ETD	Electron Tube Dist.
F	Fairchild Australia Pty. Ltd.
GRA	General Radio Agencies
GE	General Electric (USA)
GEC	General Electric Co. (UK)
GES	General Electronic Services
HW	Hurtle Webster
HOL	R.G. Holloway
H	Haco Distributors (National)
HS	Hawker Sidley
J	Jabel
McH	McKenzie & Holland (Westinghouse)
MAS	Master Instrument Co. Pty. Ltd.
MOR	Morganite (Aust.) Pty. Ltd.
MSP	Manufacturers Special Products (AWA)
McM	McMurdo (Aust.) Pty. Ltd.
MOT	Motorola
NU	Nu Vu Pty. Ltd.
NAU	A.G. Naunton Pty. Ltd.
NS	National Semiconductor
PA	Painton
PAL	Paton Elect. Pty. Ltd.
PI	Piher Resistors (Sonar Electronics)
PH	Philips Electrical Ind. P/L
PL	Plessey Pacific
PRO	Procel
PV	Peaston Vic.
RC	Radio Corp. (Electronic Inds.)
RCA	Radio Corporation of America
RHC	R.H. Cunningham
STC	Standard Telephone & Cables
SI	Siemens Electrical Industries
SIM	Simonson Pty. Ltd.
SF	Selectronic Components
SON	Sonar Electronics
TR	Trimax Erricson Transformers
TI	Texas Instruments Pty. Ltd.
TH	Thorn Atlas
UC	Union Carbide
W	Wellwyn Resistors (Cannon Elec. P/L)
WH	Westinghouse
Z	Zephyr Prod. Pty. Ltd.

CCT	DESCRIPTION			MFR	PART NO.
	RESISTORS				
R1	6.8KΩ	¼ Watt	5%	MO	
R2	10KΩ	¼ Watt	5%	MO	
R3	12K	¼ Watt	5%	MO	
R4	6.8KΩ	¼ Watt	5%	MO	
R5	330R	¼ Watt	5%	MO	
R6	47KΩ	¼ Watt	5%	MO	
R7	820Ω	¼ Watt	5%	MO	
R8	47KΩ	¼ Watt	5%	MO	
R9	1KΩ	¼ Watt	5%	MO	
R10	Selected Note 6		5%	MO	
R11	Selected Note 6		5%	MO	
R12	470KΩ	¼ Watt	5%	MO	
R13	6.8KΩ	¼ Watt	5%	MO	
R14	1KΩ	¼ Watt	5%	MO	
R15	2.2KΩ	¼ Watt	5%	MO	
R16 A&B	0.2Ω	20 Watt	5%	WW	
R17	820KΩ	¼ Watt	5%	MO	
R18	2.2KΩ	¼ Watt	5%	MO	
R19	22KΩ	¼ Watt	5%	MO	
R20	Selected Note 7		5%	MO	
R21	470Ω	¼ Watt	5%	MO	
R22	2.2KΩ	¼Watt	5%	MO	
R23	4.7KΩ	1 Watt	5%	MO	
R24	82KΩ	¼ Watt	5%	MO	
R25	5.6KΩ	¼ Watt	5%	MO	
R26	100Ω	1 Watt	5%	MO	
R27	100Ω	1 Watt	5%	MO	
R28	0.1Ω	5 Watt	5%	WW	
R29	36KΩ	¼ Watt	1%	MO	
R30	36KΩ	¼ Watt	1%	MO	
R31	6.8Ω	¼ Watt	5%	MO	
R32	10KΩ	¼ Watt	5%	MO	
R33	12KΩ	¼ Watt	5%	MO	
R34	6.8KΩ	¼ Watt	5%	MO	
R35	330Ω	¼ Watt	5%	MO	
R36	47KΩ	¼ Watt	5%	MO	
R37	820Ω	¼ Watt	5%	MO	
R38	47KΩ	¼ Watt	5%	MO	
R39					
R40	Selected Note 6		5%	MO	
R41	Selected Note 6		5%	MO	
R42	470KΩ	¼ Watt	5%	MO	
R43	6.8KΩ	¼ Watt	5%	MO	
R44	1KΩ	¼ Watt	5%	MO	
R45	2.2KΩ	¼ Watt	5%	MO	
R46	0.2Ω	20 Watt	5%	WW	
R47	820KΩ	¼ Watt	5%	MO	
R48	2.2KΩ	¼ Watt	5%	MO	
R49	22KΩ	¼ Watt	5%	MO	
R50	Selected Note 7		5%	MO	
R51	470Ω	¼ Watt	5%	MO	
R52	2.2KΩ	¼ Watt	5%	MO	
R53	4.7KΩ	1 Watt	5%	MO	

CCT REF.		DESCRIPTION			MFR.	PART NO.
R54		82KΩ	¼ Watt	5%	MO	
R55		5.6KΩ	¼ Watt	5%	MO	
R56		100Ω	1 Watt	5%	MO	
R57		100Ω	1 Watt	5%	MO	
R58		0.1Ω	5 Watt	5%	WW	
R59		1KΩ	5 Watt	5%	MO	
R60		1KΩ	5 Watt	5%	MO	
R61		2.2KΩ	¼ Watt	5%	MO	
R62		10KΩ	¼ Watt	5%	MO	
R63						
R64						
R65		10KΩ	¼ Watt	5%	MO	
R66		2.2KΩ	¼ Watt	5%	MO	
R67		27KΩ	¼ Watt	1%	MO	
R68		27KΩ	¼ Watt	1%	MO	
R69	A&B	1KΩ	¼ Watt	5%	MO	
R70	A&B	100Ω	¼ Watt	5%	MO	
R71	A&B	330Ω	¼ Watt	5%	MO	
R72	A&B	4.7KΩ	¼ Watt	5%	MO	
R73	A&B	0.1Ω	5 Watt	5%	WW	
R74	A&B	0.1Ω	5 Watt	5%	WW	
R75	A&B	27Ω	75 Watt	5%	WW	
R76	A&B	27Ω	75 Watt	5%	WW	
R77	A&B	27Ω	75 Watt	5%	WW	
R78	A&B	0.1Ω	5 Watt	5%	WW	
R79	A&B	0.1Ω	5 Watt	5%	WW	
R80		2.2KΩ	¼ Watt	5%	MO	
R81		2.2KΩ	¼ Watt	5%	MO	
R82		510 Ω	¼ Watt	5%	MO	
R83		510Ω	¼ Watt	5%	MO	
R84		1KΩ	¼ Watt	5%	MO	
R85		330Ω	¼ Watt	5%	MO	
R86		330Ω	¼ Watt	5%	MO	
R87		100 Ω	1 Watt	5%	MO	
R88						
R89		100 Ω	1 Watt	5%	MO	
R90		1KΩ	¼ Watt	5%	MO	
R91		1M Ω	¼ Watt	5%	MO	
R92		1M Ω	¼ Watt	5%	MO	
R93		10K Ω	¼ Watt	5%	MO	
R94		10K Ω	¼ Watt	5%	MO	

CAPACITORS

CCT REF	DESCRIPTION				MFG.	PART NO.
C1	100uF	63V		ELEC	PH	
C2	220uF	16V		ELEC	PH	
C3	22uF	25V		ELEC	PH	
C4	330pF	630V	10%	PYS		
C5	470pF	630V	10%	PYS		
C6	680pF	630V	10%	PYS		
C7	10uF	25V		ELEC	PH	
C8	390pF	630V	10%	PYS		
C9	47uF	25V		ELEC	PH	
C10	470pF	630V	10%	PYS		
C11						
C12	0.001uF	630V		CDS		
C13	0.0022uF	400V	10%	PYE		
C14	10uF	160V		ELEC	ELNA	TYPE RT
C15	8000uF	100F		ELEC	ELNA	TYPE RG
C16	0.1uF	630V	10%	PYE		
C17	100uF	63V		ELEC	PH	
C18	220uF	16V		ELEC	PH	
C19	22uF	25V		ELEC	PH	
C20	330pF	630V	10%	PYS		
C21	470pF	630V	10%	PYS		
C22	150pF	630V	5%	N750 CDS	S	
C23	10u	25V		ELEC	PH	
C24	220pF	630V	10%	PYS		
C25	47uF	25V		ELEC	PH	
C26	470pF	630V	10%	PYS		
C27						
C28	0.001uF	630V	10%	CDS	S	
C29	0.0022uF	400V	10%	PYE		
C30	10uF	160V		ELEC	ELNA	TYPE RT
C31	8000uF	100V		ELEC	ELNA	TYPE RG
C32	0.1uF	630V	10%	PYE		
C33	470pF	630V	10%	PYS		
C34	0.001uF	630V	10%	PYE		
C35	0.022	100V	10%	PYE		
C36	4.7uF	63V		ELEC	PH	2222-015-18478
C37						
C38	0.047uF	100V	10%	PYE		
C39	0.047uF	100V	10%	PYE		
C40	4u7	350V		ELECT	PH	
C41	2200uF	100V		ELEC	ELNA	TYPE RG
C42	1.0uF	200V	10%	PYE		
C43	2200uF	100V		ELEC	ELNA	TYPE RG
C44	68pF	600V	5% N750		CDS	S
C45	1uF	200V	10%	PYE	ELNA	TYPE N
C46	470pF	630V	10%	PYS		

CCT REF.	DESCRIPTION		MFG.	PART NO.
	SEMI-CONDUCTORS			
D1	Diode	Si	S	IN4004
D2	Zener Diode	Si	PH	BZX79C6V2
D3	Diode	Si	PH	IN4148
D4	Diode	Si	PH	IN4148
D5	Diode	Si	PH	IN4148
D6	Diode	Si	PH	IN4148
D7	Diode	Si	MOT	MR752
D8	Diode	Si	S	IN4004
D9	Diode	Si	PH	BYX21/200
D10	Diode	Si	S	IN4004
D11	Diode	Si	S	IN4004
D12	Zener Diode	Si	PH	BZX79C6V2
D13	Diode	Si	PH	IN4148
D14	Diode	Si	PH	IN4148
D15	Diode	Si	PH	IN4148
D16	Diode	Si	PH	IN4148
D17	Diode	Si	MOT	MR752
D18	Diode	Si	PH	IN4148
D19	Diode	Si	PH	BYX21/200
D20	Diode	Si	S	IN4004
D21	Diode	Si	PH	IN4148
D22	Diode	Si	PH	IN4148
D23	Diode	Si	PH	IN4148
D24	Diode	Si	PH	IN4148
D25	Diode	Si	PH	IN4148
D26	Diode	Si	PH	IN4148
D27	Diode	Si	PH	IN4148
D28	Diode	Si	S	IN4004
D29	Diode	Si	S	IN4004
D30	Diode	Si	S	IN4004
DR1	Bridge Rectifier	Si	S	VK448
DR2	Bridge Rectifier	Si	S	VK448
SCR1	Silicon Controlled Rectifier	Si	MOT	MCR3818-3
SCR2	Silicon Controlled Rectifier	Si	MOT	MCR3818-3
Q1)				
Q2)				
Q3)	Incorporated in IC1 and IC2			
Q4)				
Q5)				
Q6)				
Q7A&B	Selected Characteristics	Si	BWD	MJE3055
Q8A&B	" "	Si	BWD	MJE3055
Q9A&B	" "	Si	BWD	MJE3055
Q10A&B	Transistor	Si	PH	BC557
Q11A&B	Selected Characteristics	Si	BWD	2N3055
Q12A&B	" "	Si	BWD	2N3055
Q13A&B	" "	Si	BWD	2N3055
Q14A&B	" "	Si	BWD	2N3055
Q15	Selected Characteristics	Si	BWD	MPF106

CCT REF.	DESCRIPTION			MFG.	PART NO.	
Q16	Transistor	NPN	Si	MOT	MJE340	
Q17	Transistor	NPN	Si	PH	BC547	
Q18	Selected Characteristics		Si	BWD	MJE340	
Q19	Selected Characteristics		Si	BWD	MPF106	Note 6
Q20	Selected Characteristics		Si	BWD	MPF106	Note 7
Q21	Transistor	NPN	Si	MOT	MJE340	
Q22	Selected Characteristics		Si	BWD	MPF106	
Q23	Transistor	NPN	Si	PH	BC547	
Q24	Selected Characteristics		Si	BWD	MJE340	
Q25	Selected Characteristics		Si	BWD	MPF106	Note 6
Q26	Selected Charateristics		Si	BWD	MPF106	Note 7
Q27	Transistor	NPN	Si	MOT	MJE340	
Q28	Transistor	PNP	Si	F	2N4889	
Q29	Transistor	NPN	Si	MOT	MJE340	
Q30	Transistor	PNP	Si	F	2N4889	
IC1A/B	Dual Differential Amp.		Si		CA3054	
IC2A/B	Dual Differential Amp.		Si		CA3054	

POTENTIOMETERS

RV1	50KΩ	2 Watt	VAR WW		
RV2	50KΩ	2 Watt	VAR WW		
RV3/4	1KΩ	2 Watt	VAR WW		
RV5	1KΩ		PRESET	S	VTP
RV6	1KΩ		PRESET	S	VTP
RV7	1KΩ		PRESET	S	VTP
RV8	10KΩ		PRESET	S	VTP
RV9	1KΩ		PRESET	S	VTP
RV10	10KΩ		PRESET	S	VTP
RV11	200Ω		PRESET CC	PIHER	PT15
RV12	200Ω		PRESET CC	PIHER	PT15
RV13	200Ω		PRESET CC	PIHER	PT15
RV14	10KΩ		PRESET CC	PIHER	PT15
RV15	10KΩ		PRESET CC	PIHER	PT15
RV16	200Ω		PRESET CC	PIHER	PT15
RV17	100Ω		PRESET CC	PIHER	PT15
RV18	200Ω		PRESET CC	PIHER	PT15
RV19	100Ω		PRESET CC	PIHER	PT15
RV20	50KΩ c/w DPST Switch		VAR CC	D	PSS2039
RV21	50KΩ c/w DPST Switch		VAR CC	D	PSS2039
RV22	2KΩ		PRESET CC	PIHER	PT15
RV23	2KΩ		PRESET CC	PIHER	PT15
RV24	500KΩ		PRESET CC	PIHER	PT15
RV25	500KΩ		PRESET CC	PIHER	PT15
RV26	470Ω		PRESET CC	PH	2322-411-022-470E

BWD 246A Parts List

CCT REF.	DESCRIPTION			MFG.	PART NO.
	SWITCHES				
S1	2 Pos.	2 Pole	Toggle Switch	AWA	8370K8
S2	2 Pos.	2 Pole	Slide Switch	McM	1299-02-02
S3	2 Pos.	2 Pole	Slide Switch	McM	1299-02-02
S4	3 Pos.	2 Pole	Toggle Switch	ARR	93A/102A-13
S5	3 Pos.	2 Pole	Toggle Switch	ARR	93A/102A-13
S6	3 Pos.	4 Pole 2 Deck Rotary	"	BWD	SR70A
S7	2 Pos.	2 Pole	Slide Switch	McM	1299-02-02
S8	2 Pos.	2 Pole	Slise Switch	McM	1299-02-02
	FUSES				
F1	5 Amp. Delay Fuse				3AG
F2	15 Amp. Q.B. Fuse				3AG
F3	15 Amp. Q.B. Fuse				3AG
	MISCELLANEOUS				
B1	6.3V Pilot Indicator			S	3280
M1	Voltmeter			BWD	246A-V
M2	Ammeter			BWD	246A-A
	ITEMS NOT LISTED ON CCT. DIAGRAM				
	Main Printed Circuit Board			BWD	160/125
	Regulator Printed Circuit Board			BWD	160/126
	Rear Panel Terminal Strip			CIN	77903-10 Way
	Circuit Diagram			BWD	No. 878

ALL OTHER ITEMS ORDER BY DESCRIPTION
QUOTING MODEL NO. AND SERIAL NO.

Note 6	Q19 & 25 V.G.S.	R10 & 40	R11 & 41
	15-20	1K5	15K
	21-28	2K2	22K
	29-30	2K7	22K
	31-32	3K3	27K
Note 7	Q20 & 26 V.G.S.	R20 & 50	
	8	1K	
	9 - 12	1K5	

MODIFICATIONS

ISSUE 2 4-76

Q24 BECOMES SELECTED COMPONENT

SEE ALSO DRG. 1190

ISSUE 3 5-77

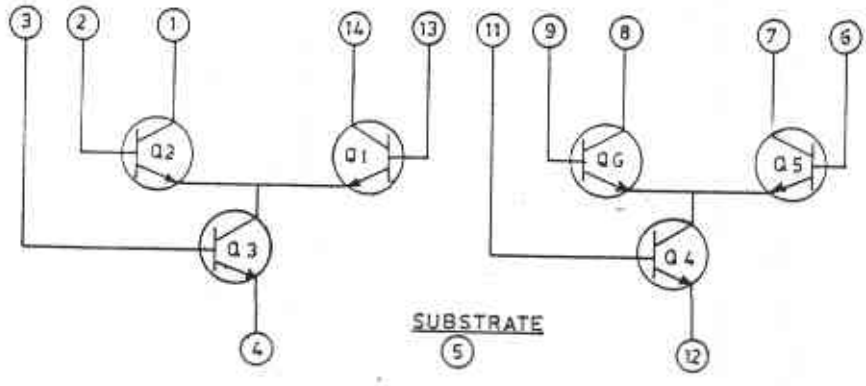
SEE DRG. No. 1190

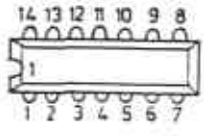
CONTROLS

RV1	OUTPUT VOLTAGE CONTROL	NO. 2
RV2	OUTPUT VOLTAGE CONTROL	NO. 1
RV3	OUTPUT CURRENT CONTROL	NO. 2
RV4	OUTPUT CURRENT CONTROL	NO. 1
RV5	MAXIMUM VOLTAGE PRESET	NO. 2
RV6	MAXIMUM VOLTAGE PRESET	NO. 1
RV7	MAXIMUM CURRENT PRESET 5A	NO. 2
RV8	MAXIMUM CURRENT PRESET 500mA	NO. 2
RV9	MAXIMUM CURRENT PRESET 5A	NO. 1
RV10	MAXIMUM CURRENT PRESET 500mA	NO. 1
RV11	CONSTANT VOLTAGE OUTPUT IMPEDANCE PRESET	NO. 2
RV12	CONSTANT VOLTAGE OUTPUT IMPEDANCE PRESET	S
RV13	CONSTANT VOLTAGE OUTPUT IMPEDANCE PRESET	NO. 1
RV14	CONSTANT CURRENT OUTPUT IMPEDANCE PRESET	NO. 2
RV15	CONSTANT CURRENT OUTPUT IMPEDANCE PRESET	NO. 1
RV16	AMMETER CALIBRATE (5A) PRESET	NO. 2
RV17	AMMETER CALIBRATE (500mA) PRESET	NO. 2
RV18	AMMETER CALIBRATE (5A) PRESET	NO. 1
RV19	AMMETER CALIBRATE (500mA) PRESET	NO. 1
RV20	CROWBAR OVERVOLTAGE CONTROL	NO. 2
RV21	CROWBAR OVERVOLTAGE CONTROL	NO. 1
RV22	CROWBAR OVERVOLTAGE RANGE PRESET	NO. 2
RV23	CROWBAR OVERVOLTAGE RANGE PRESET	NO. 1
RV24	MINIMUM CURRENT PRESET	NO. 2
RV25	MINIMUM CURRENT PRESET	NO. 1
RV26	VOLTMETER CALIBRATE PRESET	-

SWITCHES

		POS. SHOWN
S1A-B	POWER ON/OFF	OFF
S2A-B	CURRENT RANGE (5A / 500mA) NO. 2	5A
S3A-B	CURRENT RANGE (5A / 500mA) NO. 1	5A
S4A-C	TERMINAL SWITCH (SET I/ SET V/ USE) NO. 2	USE
S5A-C	TERMINAL SWITCH (SET I/ SET V/ USE) NO. 1	USE
S6A-H	FUNCTION SWITCH (SERIES/INDEPENDENT/PARALLEL)	PARA
S7A-B	VOLTMETER SELECTOR (NO.1 / NO.2)	NO.1
S8A-B	AMMETER SELECTOR (NO.1 / NO.2)	NO.1



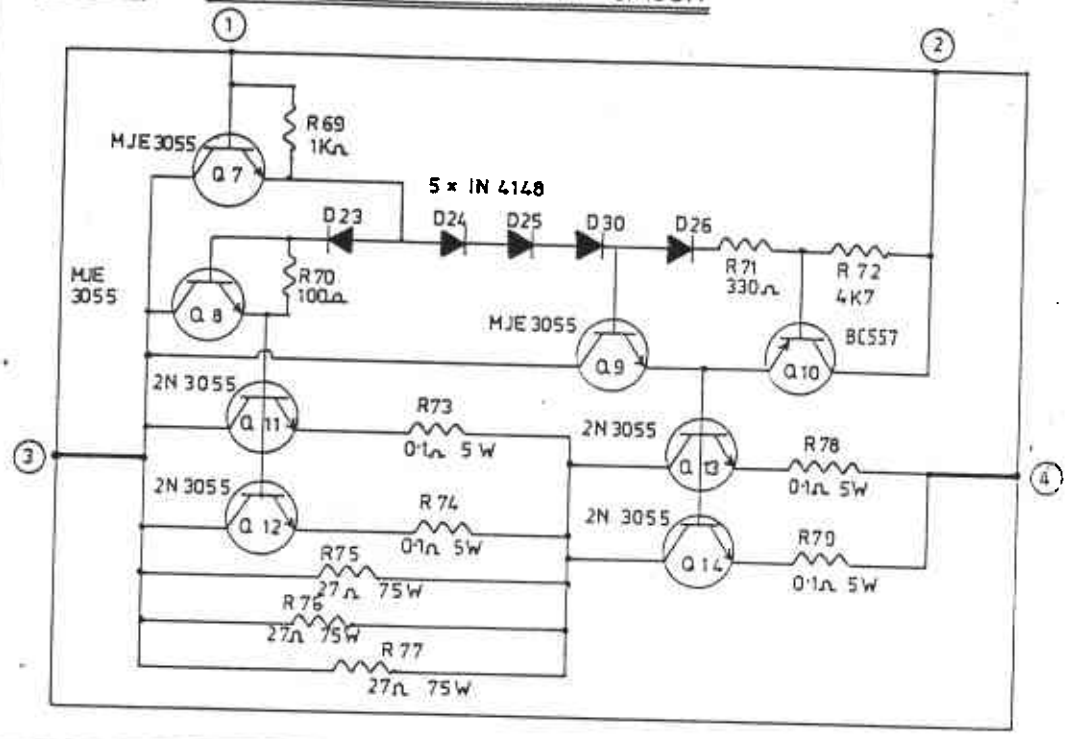


TOP VIEW

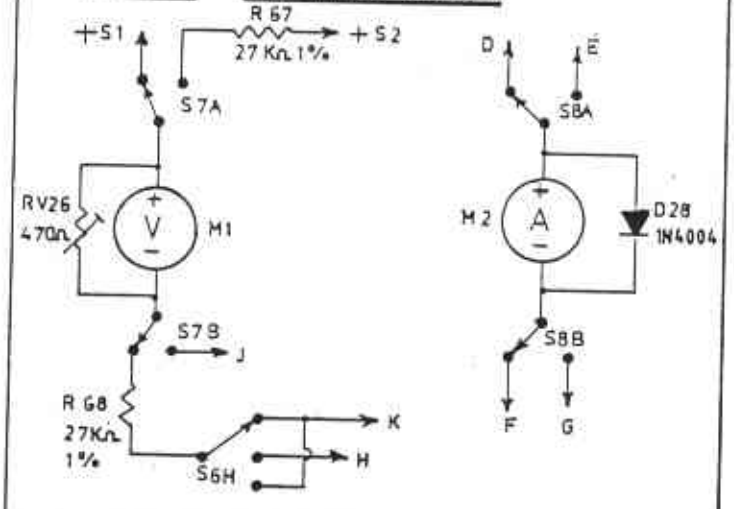
NOTE 1 INTEGRATED CIRCUIT SCHEMATIC

	MPF 106	2N 3819
1	G	S
2	S	G
3	D	D

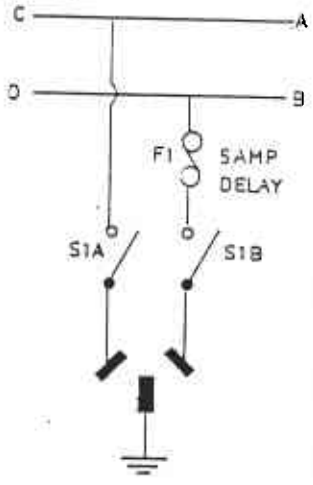
NOTE 2 REGULATOR AND DRIVER CIRCUIT



NOTE 3 METERING CIRCUIT

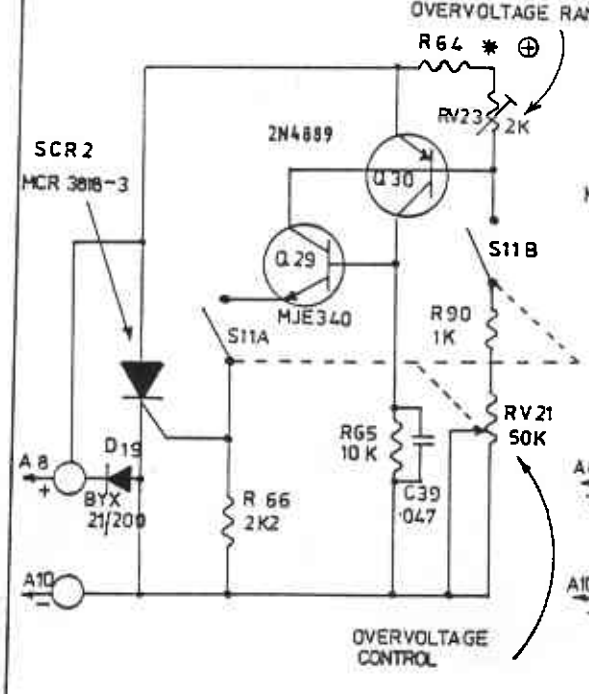


NOTE 4

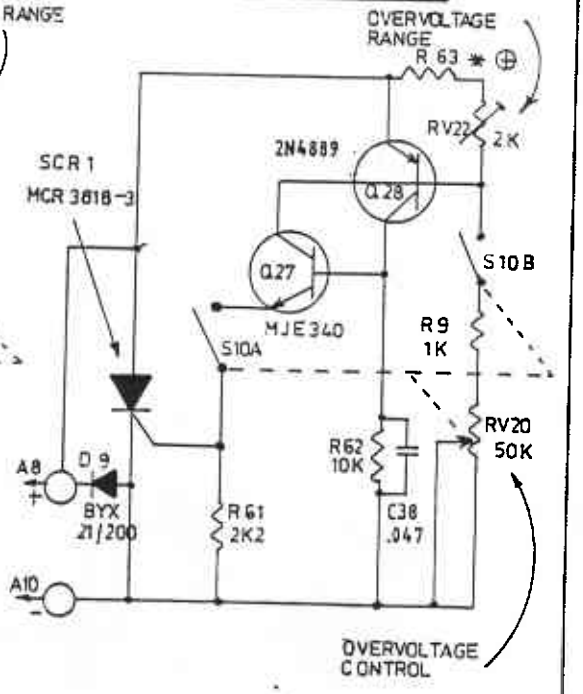


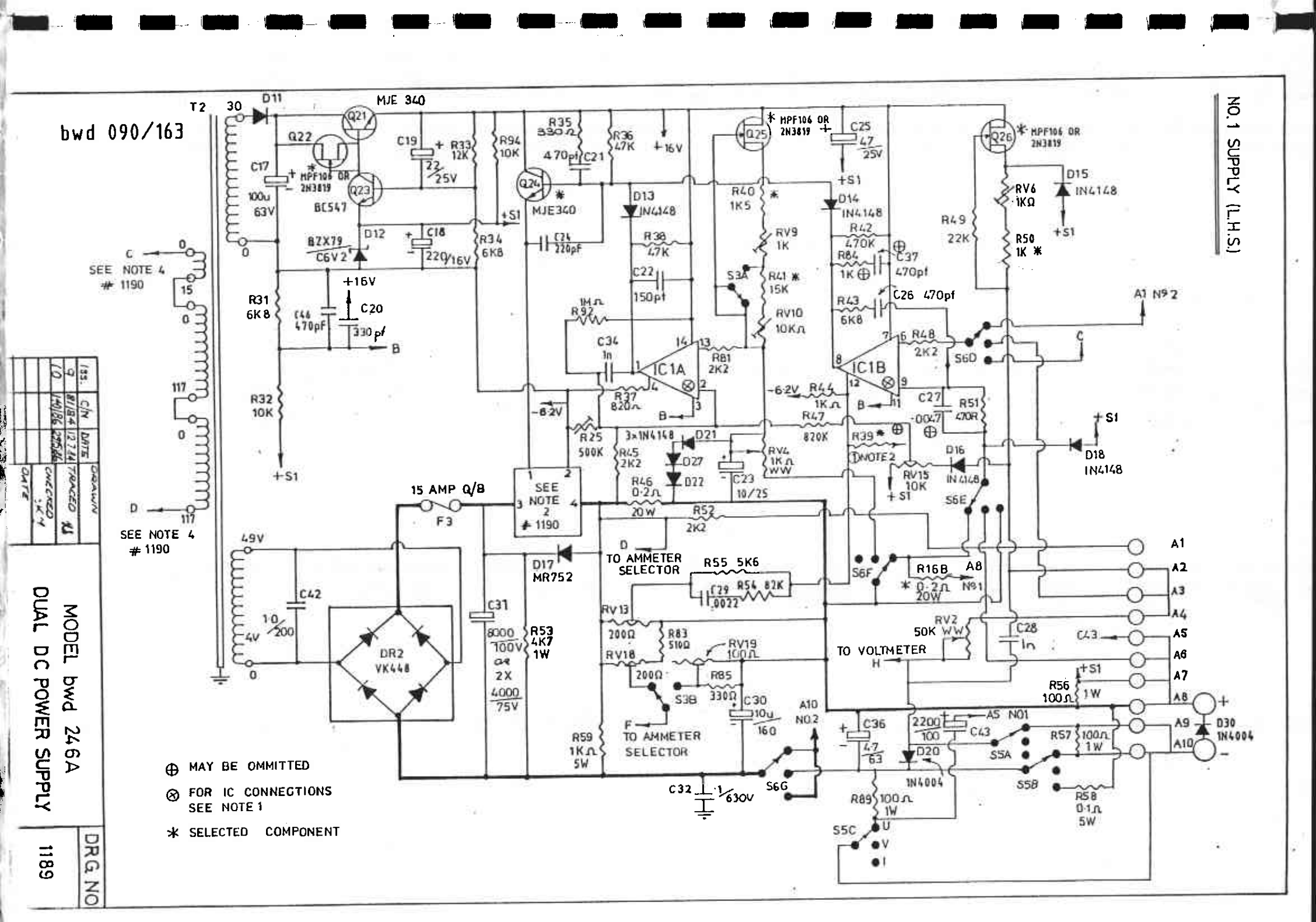
NOTE 5 CROWBAR OVERLOAD.

NO. 1 SUPPLY

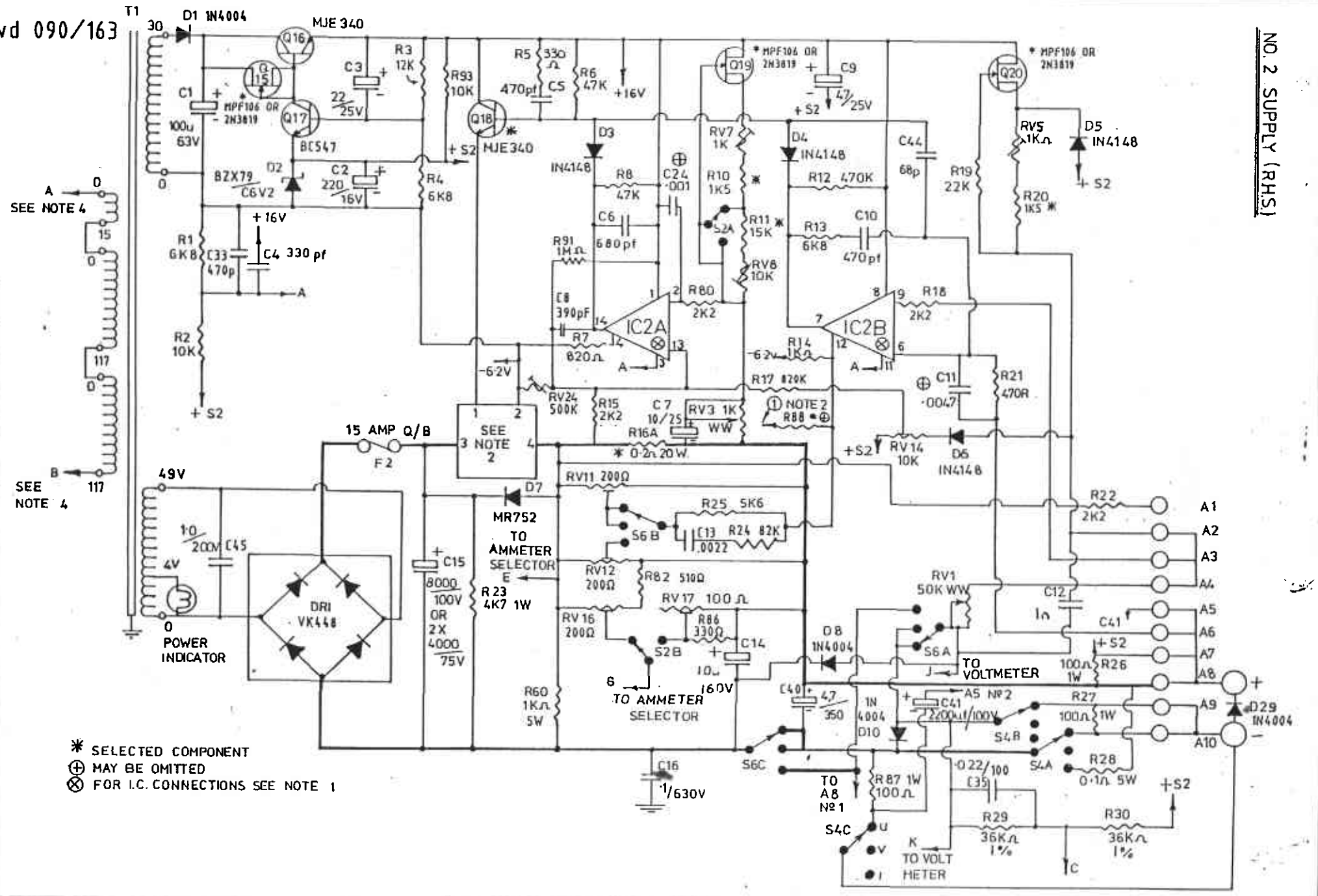


NO. 2 SUPPLY




bwd 090/163
NO.1 SUPPLY (L.H.S.)
MODEL bwd 246A
DUAL DC POWER SUPPLY
DRG NO 1189
ISS. C/N DATE DRAWN
Q 81/84 12/7/84 TRACED
10 140/86 25/5/86 CHECKED
DATE
T2
30
D11
MJE 340
Q21
Q22
Q23
Q24
Q25
Q26
MPF106 OR 2N3819
BC547
C17 100u 63V
C19 22/25V
R33 12K
R94 10K
R35 330Ω
470pf C21
R36 47K
+16V
C24 220pF
D13 IN4148
R38 47K
C22 150pf
R34 6K8
+S1
BZX79 C6V2
D12
C18 220/16V
R31 6K8
C46 470pF
C20 330pf
B
R32 10K
R92 1MΩ
C34 1n
IC1A
IC1B
R81 2K2
R37 820Ω
-6·2V
R25 500K
3×1N4148
D21
D27
D22
R45 2K2
R46 0·2Ω 20W
C23 10/25
RV4 1K Ω WW
R40 1K5
RV9 1K
R41 15K
RV10 10KΩ
S3A
D14 IN4148
R42 470K
R84 1K
C37 470pf
C25 47 25V
R49 22K
RV6 1KΩ
R50 1K
D15 IN4148
C26 470pf
R43 6K8
R48 2K2
S6D
A1 N92
C
R44 1KΩ
C27 ·0047
R51 470R
R47 820K
R39 NOTE 2
RV15 10K
D16 IN4148
S6E
D18 IN4148
SEE NOTE 4 # 1190
C
0
15
0
117
0
D
117
SEE NOTE 4 # 1190
15 AMP Q/B
F3
SEE NOTE 2 # 1190
1
2
3
4
R52 2K2
TO AMMETER SELECTOR
D
R55 5K6
C29 ·0022
R54 82K
S6F
R16B * 0·2Ω 20W
A8
N91
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
49V
4V
C42 10/200
DR2 VK448
C31 8000/100V or 2X 4000/75V
R53 4K7 1W
D17 MR752
RV13 200Ω
R83 510Ω
RV18 200Ω
RV19 100Ω
S3B
R85 330Ω
C30 10u 160
F
TO AMMETER SELECTOR
R59 1KΩ 5W
A10 NO2
S6G
C32 1/630V
TO VOLTMETER
H
RV2 50K WW
C28 1n
C43
+S1
R56 100Ω 1W
C36 4·7 63
2200/100 C43
A5 NO1
S5A
S5B
R57 100Ω 1W
D20 1N4004
R58 0·1Ω 5W
R89 100Ω 1W
S5C
U
V
I
D30 1N4004
⊕ MAY BE OMMITTED
⊗ FOR IC CONNECTIONS SEE NOTE 1
* SELECTED COMPONENT

bwd 090/163



NO. 2 SUPPLY (RHS)

ISS.	C/N	DATE	DRAWN
9	81184	12784	TRACED
10	14064	23584	CHECKED
			DATE

MODEL bwd 246A

DUAL DC POWER SUPPLY

DRG. NO. 1190

MANUAL CHANGE INFORMATION FOR MODEL BWD:246A.

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
22700	1		44437	6 & 7	6.80
32000	2				
36900	3	5.77			
22700	4	7.79			
45000	5	5.80			

Issue	Sect.	Page	Cct.	AMENDMENT
1	P/L	2A		Add R91 10KΩ ½watt 5% CC
	P/L	2A		Add R92 10KΩ ½watt 5% CC
2		42		Fig. 2: If T163A Power Transformer is fitted amend Fig. 2 as shown below. NOTE: T163B requires no change.

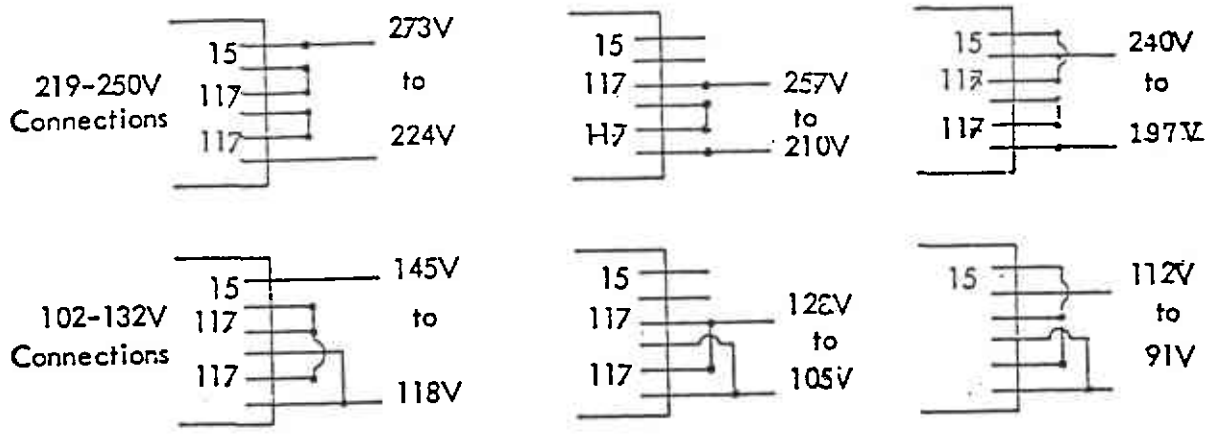


Figure 2. Transformer Connections

3	A	5	1189	Q24 becomes selected component.
3	A	5	1190	Q18 becomes selected component, Q15 becomes Q16 and Q16 becomes Q15.
4	2	3		Para 2:4(i) 1.3KΩ was 680Ω
4	3	4		'Crowbar Overload' sub-heading 'Option 08 only' removed.
4	4	9		Para 4:5 1.3KΩ was 680Ω
4	4	36		Para 4:25 6800 was 340Ω
4	6	46		Para 6:18 '(crowbar overload normally fitted)' added.
4	9	48		Para 9:5 (Normally fitted as standard) added to heading.
5	A	2	1189& 1190	R91 & 92 1MΩ added.
5	A	3	"	C4 & C21 were 159pf 630V.
5	A	5	"	RV1 & RV2 incorrectly shown as 25K.
6	A	3A		C6 specified correctly as 680pf on Parts List.
6			1190	C33 correctly labelled.
7	A	3	1190	C44 added.

MANUAL CHANGE INFORMATION FOR MODEL BWD:246A.

FROM SERIAL NO.	ISSUE	DATE	FROM SERIAL NO.	ISSUE	DATE
47849	8	1.81			
	9	1.81			
50800	11	9.82			
	12	9.82			
	13	7.86			

Issue	Sect.	Page	Cct.	AMENDMENT
8	A	3	1189& 1190	C1 & C7 were 68uf 63V
8	A	2	"	R91 & 92 duplicates, change 10K R91 & 92 to R93 & R94
8	A	1 & 2	"	R21 & 52 changed from 100Ω to 470Ω
8	A	3	"	C44 changed from 22pf to 68pf.
9	A	3	1190	C35 change from 6.4u 400V to 4.7u 350V
	A	3	1189& 1190	C14 & 30 change from 12.5u 150V to 100u 160V
11		P/L		BYX21/200 Diode replaced by IN3493
11	2	2		135Ω is now 335Ω approx.
	2	2		200mV is now 235mV approx. Same in page 4-7
	9	4		)Typing errors
	13	4		) " "
	14	4		) " " DRAWING - PIN A2 NOT CONNECTED TO A1.
	15	4		) " "
	16	4		) " "
	33	4		) " "
	19	4		68Ω is now 180Ω
	20	4		100mV is now 135mV
	31	4		680Ω is now 1.3K
	32	4		135Ω is now 340Ω & 100mV - 235mV
	1	9		OPTION 2 CORRECTED.
		P/L		RESISTORS TOLERANCE CHANGED.
12		P/L		UPDATE
13	A	4		Q7,8,9,11,12,13 & 14 Selected characteristics.
13	A	5		RV24 & RV25 were 1MΩ.