POWER SUPPLY – BWD 255

BWD Model 255 – Solid State D.C. Power Supply
S.N. 7707
eBay Feb 2020

T1 A&R 6309 33-0-33V secondary Pri DCR=16 ohm

Issues:
Mains protective earth not directly bonded to chassis.
Primary wiring mixed with secondary wiring in rear wall loom to Tx, and through grommet near front.
Loose nut wedged in transformer.
Check for any fault fixing.
Revisions - R58 = 820R; C7=100uF; no C12 fitted; R21=1k8 1W; C11 on input.
C2x shown with wrong polarity on pcb.
Sense terminals wired to main terminals.
C11 replaced
Fuse F2 goes to C5 pos (blu) but also to Sw2 (this connection should come straight from C5)
C5 negative (blk) goes direct to Sw2, and splits at Sw2 (rather than splitting at C5 neg) – one split to output terminal, and other split to R46 and R25 (could extract that black wire from loom and take direct to C5.
1k 10W has 87V across it = 7.6W.

Megger tested AC primary: 800Meg.
60V range C5=87V; 30V range C5= 50V; Aux supply = 33V.
All adjustments done except stability compensation.

Note:
Terminal 15 with 1Meg resistor to Q9X base

Modifications:
- Added protective earth chassis bolt and PE connect.
- Mains side wiring removed from secondary side looms.
- 432KD10 MOV on T1 primary terminals.
- C5 swapped for 2x 2,200uF 160V. C7 swapped for220uF 63V. C2x swapped for 47uF 50V.
- Fuse F2 direct to C5. R46 and R25 direct to C5. Output neg terminal direct to C5.
- D14-D17 bridge replaced with UF4007.
- Added 2k7 in series with R41 (=1k2) to calibrate voltmeter reading. 60k resistor was accurate.
- 1k8 // 2k2 10+10W to replace 1k 10W
- Repaired ON bezel and replaced neon with orange LED.

To do:
- Stability compensation tests.
- Megger test C10. Megger test floating supply to chassis to +/-250V, and note insulation regions.
- CRC snubber on main secondary half-windings.
- 6F15 main bridge diodes – check fast replacements and re-wire for lower loop area.

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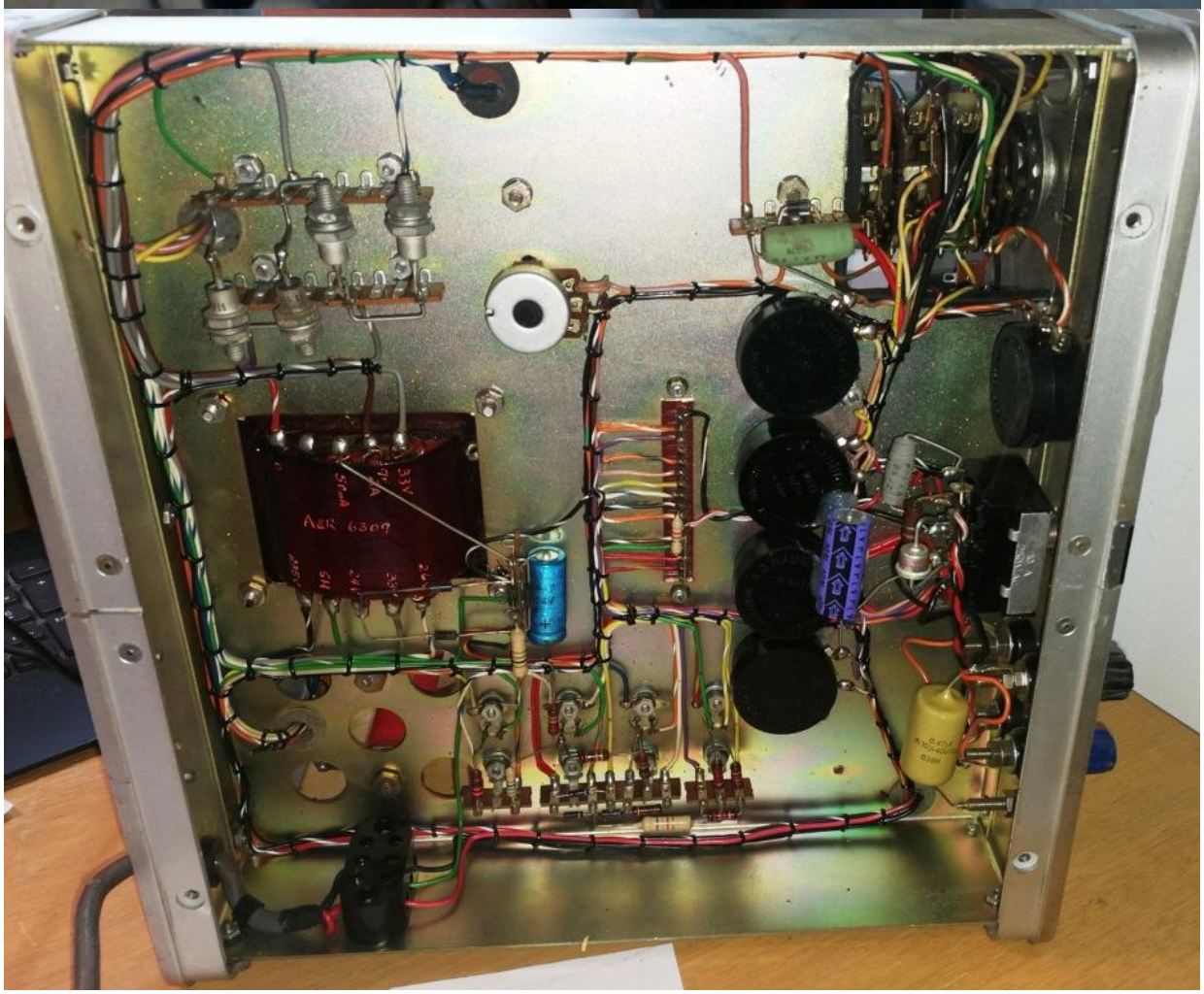

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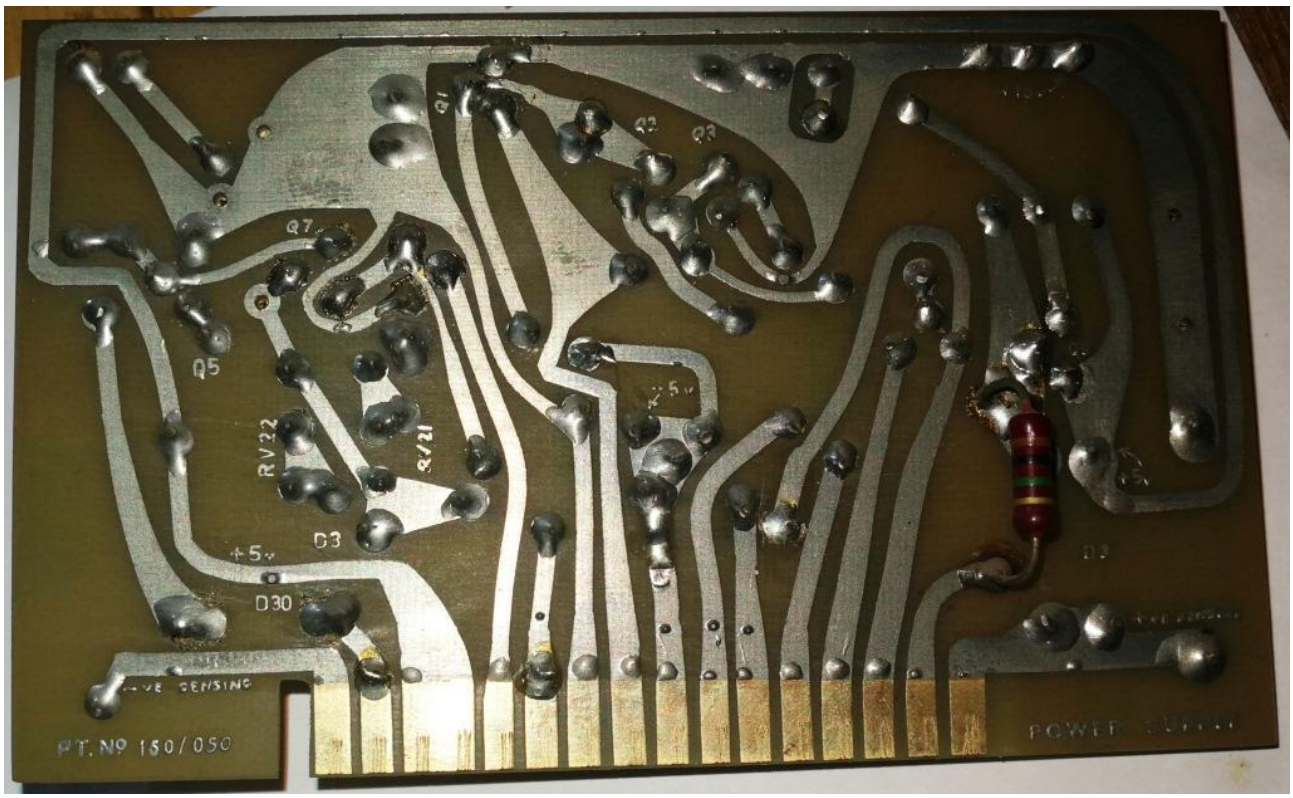

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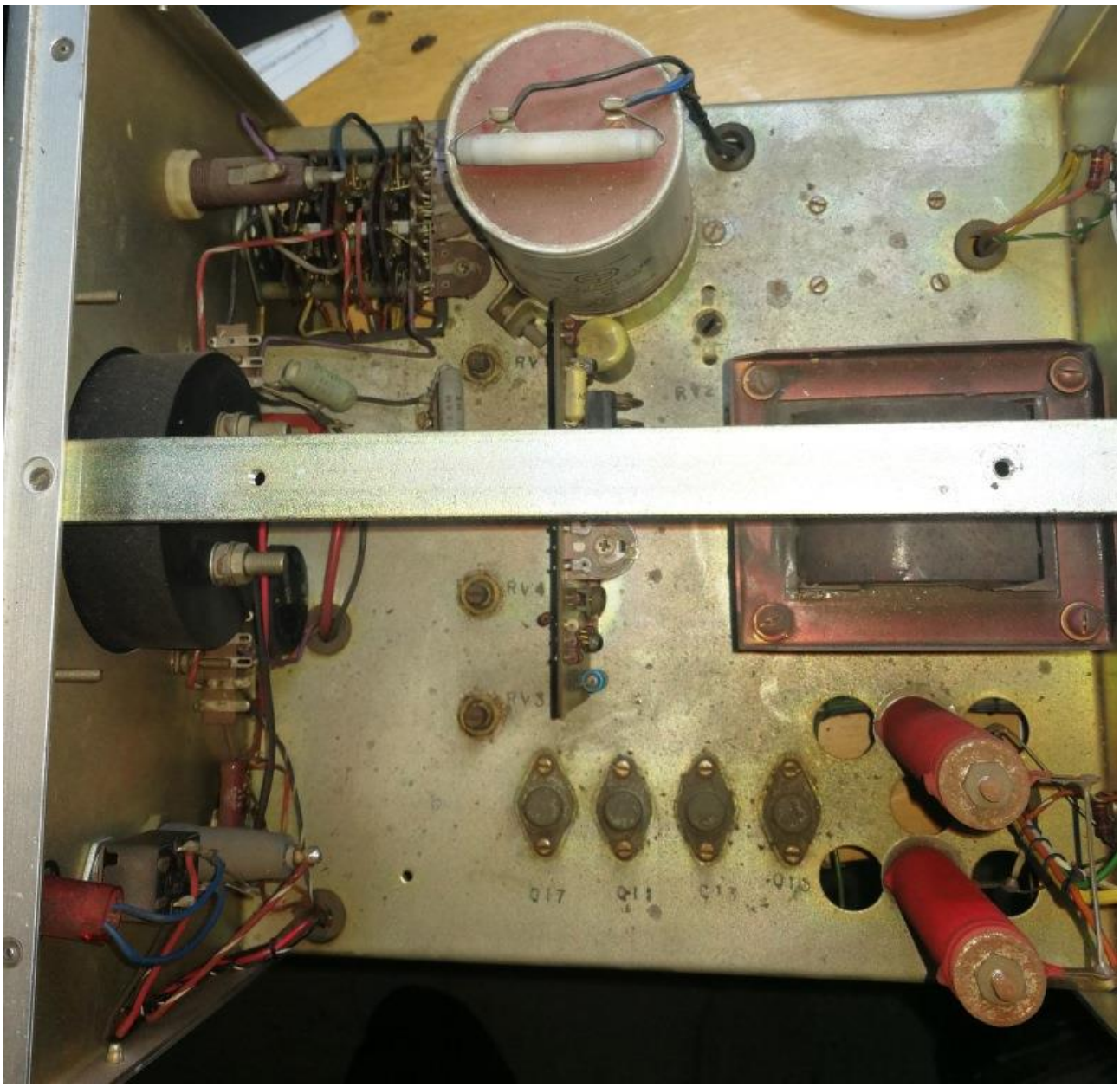

INSTRUMENT HANDBOOK

Applicable to Serial No.....

MODEL bwd-255

SOLID STATE D.C. POWER SUPPLY

INDEX

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INSTRUMENT HANDBOOK

MODEL 255 D.C. POWER SUPPLY

1. GENERAL — Model 255 dual range 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 operated over the following ranges :

0 - 30V at 2 Ampere

0 - 30V at 200mA

0 - 60V at 1 Ampere

0 - 60V at 200mA

Two ammeter ranges of 0-200mA and 0-2 Amp are automatically brought into circuit as the appropriate range is selected.

The constant current or automatic overload current rating can be preset before the supply is connected to an external load by pressing the short circuit push button on the front panel and setting the required current with the fine control over the selected current range.

Very high stability and high regulation ratios are ensured by the advanced B.W.D. circuit design and the use of reliable, stable silicon transistors and diodes throughout. All components are conservatively rated to permit operation over a 0 - 45°C range and to accommodate variation in input voltage from 210 to 255V as selected on the power transformer.

NOTE: For reliable operation at least 2" of free space must be left at the rear of the heat sinks to ensure free flow of air past the power transistors.

2. PERFORMANCE

	RANGE	
CONSTANT VOLTAGE OUTPUT Continuously variable without switching.	0 - 30V	0 - 60V
Current Range Low range	0 - 210mA	0 - 210mA
High range	0 - 2,1A	0 - 1,1A
Stabilisation Ratio For mains change of ± 10%	50000 : 1	5000 : 1
Output Impedance		
DC to 100Hz	1mΩ	1mΩ
100Hz to 1kHz	5mΩ	5mΩ
1kHz to 100kHz	0,1Ω	0,1Ω
100kHz to 1MHz	1,0Ω	1,0Ω
Ripple peak to peak at full load.	< 500μV	< 500μV
Response Time (to within 10mV of output) No load to full load.	50μ Sec	50μ Sec
Temp. Stability	0,01%/°C + 2mV	
Long Term Stability 8 hrs. Constant Load and Temp.	0,02%	0,04%
CONSTANT CURRENT OUTPUT continuously variable in 2 ranges.	20 - 210mA 0,2 - 2,1A	20 - 210mA 0,2 - 1,1A
Output Impedance	100KΩ	100KΩ
Current Ripple p-p max.	500μA	500μA
Upper Voltage Limit continuously variable	0 - 30V	0 - 60V
Current Stabilisation Ratio for a mains change of ± 10%	1000 : 1	1000 : 1

VOLTAGE AND CURRENT SETTING

Four switched ranges by a selector switch.
30V, 200mA or 2 Amp.
60V, 200mA or 1 Amp.

A push button switch shorts the output to enable max. current to be accurately set with variable control.

METER

$4\frac{1}{2}$" meter scaled 0 - 60V
0 - 200mA
0 - 2A

Accuracy 2% FSD all ranges.

OUTPUT POLARITY

Supply is completely isolated and may be taken to ± 250V from ground and either side may be earthed.

REMOTE SENSING

Terminals provided to permit voltage regulation to be maintained at end of long connecting leads.

STANDBY/USE SWITCH

Switch isolates both output load and remote sensing terminals to enable voltage and current conditions to be preset before applying to load and to eliminate 'warm up' delays each time load must be disconnected.

ENVIRONMENTAL CONDITIONS

Operating range 0 - 45°C at full load.
0 - 90% R.H.

OUTPUT TERMINATIONS

Heavy current insulated screw terminals at $\frac{3}{4}$" CRS. Terminals accommodate 4mm. plugs, spade terminals or wire.
Sensing terminals as above.
Ground terminal uninsulated.

POWER REQUIREMENTS

210V to 255V)
or) @ 50Hz Full stabilisation and regulation
105V to 127V) maintained over this range.

3. CONTROLS AND THEIR FUNCTIONS

AC ON - OFF — Input power switch.

AC FUSE — 1 amp delay fuse fitted after power switch in AC power line.

AC INDICATOR — Neon indicator lamp across the AC input line.

DC FUSE — 5 Amp Delay Fuse fitted between rectifiers and input filter capacitor.

OUTPUT VOLTAGE AND CURRENT RANGE SELECTOR — Selects the required voltage range together with the max. current output required. This switch can be operated with the supply under load without damage to the supply itself.

OUTPUT VOLTAGE — Continuously variable control to set output voltage from zero to 30V or 60V as selected by range switch.

PRESS TO SET CURRENT BUTTON — Switches a 0.5Ω load across output to put supply into a constant current condition when supply voltage is greater than 3V.

SET CURRENT VERNIER — When S.C. button is pressed Vernier permits any current setting within the selected range.

METER SCALE SWITCH — Selects either Voltage or Current scale on meter.

STANDBY/USE SWITCH — Disconnects output terminals and remote sensing terminals in standby position.

TERMINALS

LOAD	-	Red (positive) and Black (Negative)
REMOTE SENSING	-	Blue Terminals.
GROUND	-	Uninsulated terminal.

NOTE: When remote Sensing leads are not being used links must be kept between load and sensing terminals to provide correct regulation and stabilisation characteristics.

The grounding of one of the output leads is recommended to minimise hum pick up on the output load particularly transcient spikes from the power rectifiers. If both sides must be isolated large capacitors (around 200 uF) may be connected from each side to ground to minimise hum pick up or a differential measuring system must be employed to eliminate the hum pick up in the load, however, external acpacitors may affect the transient response of the supply.

To prevent the output of the supply rising above ground potential when ungrounded a 1MΩ and 0.47 uF capacitor are internally connected from the negative line to chassis.

4. OPERATION

CONSTANT VOLTAGE

Put the STANDBY/USE Switch to STANDBY and the RANGE Switch to the output required, always work on the lowest range that will supply the required voltage. Switch ON and set the output voltage. Next press the push button and set the current with the Vernier Control to the required maximum overload current, release button. Connect equipment under test to output terminals (Red and Black) and ensure links to remote sensing terminals are in place, apply power to load by switching to USE.

If the output voltage drops to zero or a low voltage the output load is drawing more current than the overload has been set for and a check should be made for possible shorts, etc.

If the load is to be operated a considerable distance from the Power Supply, Remote Sensing may be employed to maintain the regulation at the end of the connecting wire. Removethe shorting links between the output terminals and the sensing terminals and connect leads, preferably 23/.0076 minimum from the sensing terminals to the point where the supply leads join the load - be certain to observe correct polarity. Any change in voltage at the load will now be fed back by the sensing leads and compensation will be made for the voltage drop in the supply leads.

NOTE: The output resistance can be calculated approximately using the equation :-

$$ZO\ Remote = 20\ (2R\ lead)^2 \times 10^{-3} + 1 \times 10^{-3}\ \Omega$$

When (i) The four leads have identical resistance equal to R Lead.
(ii) R Lead $\leq 0.5\Omega$.

CONSTANT CURRENT

Setting Up procedure is as previously described for constant voltage but the voltage is set to the maximum upper limit that is required across the load, if no limit exists set the voltage at 30 or 60V depending on the range required.

The current required to flow through the load is set as above, by pressing the shorting button and setting the required value by the vernier and range switch.

NOTE: Any front panel control may be switched or varied when the supply is operating under load including the RANGE Switch without damage to the supply in any way.

5. CIRCUIT DESCRIPTION

From the circuit diagram it will be noticed that a group of components forming the control circuits in the centre of the supply are contained in a double dotted line. All components within this border have the letter X after their code number, e.g. R4X. These components are mounted on the plug-in printed circuit board.

Pin numbers on the printed circuit connector are shown contained in circles around the edge of the border.

A.C. input is taken through S1A and B mains switch and F1 primary fuse to transformer T1 and to B1 indicator lamp. Three secondaries on T1 provide the main and auxilliary supplies.

The main winding is a 34-0-34 secondary with a tap at 26V on one side. In the 30V positions of the range switch S2, D10 and 12 full wave rectify the 34-0-34 secondary but in the 60V positions D9 and 11 are brought into circuit and with D10 and 12 they form a bridge circuit across the 34-0-34 (60V) section of the transformer. Filtering is by a single capacitor C5.

AUXILLIARY STABILISED REFERENCE SUPPLIES

Three voltages are used by the control amplifier and are all referred to the +ve output line or +ve remote sensing rail.

A negative -5V rail is obtained by returning the negative end of the auxilliary supply through a zener D7X to the +ve remote sensing rail. The +18V rail is controlled by Q17 series regulator and Q8X and 9X feedback amplifiers with the zener reference diode D5X providing both the main 6.2V reference source and the reference for Q9X.

The emitter of Q9X is held by D5X at approximately 6.2V and its base is controlled by a divider R17X and R19X. If the +18V line is low the base voltage of Q9X will be low compared with its emitter so its collector will rise causing Q8X (PNP) transistor to reduce conduction and so permit more base current to be available for Q17 via R35. Q17 conduction will increase and its emitter will rise pulling the voltage on Q9X base up, via the divider R17X and R19X until a quiescent state is reached. A rise in the + 19V line will cause the reverse action to take place.

CONSTANT VOLTAGE OPERATION (30V @ 2A RANGE)

Q2X and Q3X differential amplifier is connected with the base of Q2X to the +ve sensing line and the base of Q3X connected to a divider consisting of RV5 output voltage control (connected to the -ve sensing line), and RV4 preset control connected to the 6.2V reference line.

In the quiescent state both bases are at approximately the same potential i.e. that of the +ve sensing line. If a load causes the output to fall the voltage developed across RV5 output control will reduce, causing the junction to which Q3X base is connected to rise. This increases the current through Q2X and the emitter rises, Q2X emitter follows biasing the transistor off slightly so causing its collector to rise. Q1X emitter follower follows the rise and increases the base current rise and increases the base current of Q15 divider which in turn increases the base current of Q16 causing it to pass a higher current to meet the output demand and to increase the output voltage to the original level. Q2X and Q3X will then return back to their quiescent state.

To reduce the output impedance to any value from -20mΩ to +20mΩ positive feed back is applied to the emitters of Q2X and Q3X via R4X and RV2 from the junction of R50 and R51. As the output current increases the junction of R50 and R51 rises positively with respect to the output terminal and this increase is applied to Q2X emitter to cause the collector to also rise. This rise is communicated to the output transistor via Q1X and Q15 and compensates for output load changes. RV1X and C1X control the high frequency loop gain and provides stable operation under all voltage and current conditions.

CONSTANT CURRENT OPERATION (30V @ 2 AMP RANGE)

When current flows from the series regulating transistor Q16 to the +ve output terminal it flows through the sensing resistor R45 developing a +ve voltage at the transistor end of the resistor. Q6X and Q7X are connected across the sensing resistors in the following manner. Q7X is taken via R12X to the input end of the sensing resistor, whilst Q6X base is connected to the output of RV6 Constant Current Vernier Control, this control is in turn connected in series with R37 and R56 with D4 to stabilise the voltage, and with R48 or the external link to the +ve output terminal.

With no output load current flowing Q6X conducts and Q7X is cut-off Q4X base is at approximately 17V and its emitter follows reverse biasing diode D1X via the divider R9X and R10X. When output load current is drawn Q7X conducts due to a positive potential applied to its base via R35X. The base and hence the emitter of Q4X will fall to approximately 1.0V with respect to the output. Diode D1X will be forward biased allowing Q4X to take control of the output.

In this quiescent condition any increase or decrease in output current will cause a change in the voltage drop across R45, this is sensed by Q6X and Q7X to increase or decrease the output voltage until the current returns to the preset value. The change in current necessary to make the output voltage change from 30V to zero is less than 300 uA.

6. RANGE AND METER SWITCHING

S2 Range switch controls several functions,each section is detailed below to simplify checking operation. The sections are lettered starting with the deck nearest the panel and clockwise around it starting with section A at the 3 o'clock position.

S2A Selects the preset to determine the output voltage range.

S2B Shorts out Q14 on 30V positions.

S2C Changes rectifiers negative output from full wave C.T., to diode bridge.

S2D Changes voltage tapping for D10 in bridge circuit.

S2E Selects Ammeter range.

S2F Not connected.

S2H Shorts out R23 on 30V ranges.

S2I Not used.

S2J Selects maximum overload current presets.

S3A and B change over meter from voltage reading with R42 and 41 in series (R41 is incorporated to eliminate switch shorting) to current reading with R47 clamping resistor in shunt.

NOTE: When Voltmeter is switched into circuit the meter is connected to the SENSING line not the output rails. This provides a two fold advantage. The true output voltage is indicated, any voltage drop in the Standby/Use switch is eliminated and when remote sensing is employed in the voltate AT THE LOAD is indicated by the meter, not the voltage across the output terminals.

7. MAINTENANCE AND ADJUSTMENTS

Component changes will not normally effect the performance of Model 255 supply subject to the replacement component being of similar size, stability and performance to the original components. Transistor requirements are detailed later in this section.

Several preset controls are contained in this instrument and are adjusted as follows :-

RV1X HF Output Impedance Preset

Connect a wide band high gain oscilloscope (1MC's minimum at 1mV) such as a B.W.D. Model 421A across the sensing terminals - external links should be in position and a variable power load across output terminals. Set output to 15V and check each range from maximum to minimum current and under short circuit conditions with external lead and panel push button. Adjust RV1X (on printed circuit board) to eliminate any trace of oscillation.

RV2 Output Impedance Preset

Set output range to 30V @ 2A. Connect a digital voltmeter across the sensing terminals, check that the links are in position. Connect a 15Ω 60 watt resistor across the output terminals. The output voltage change should be less than 2mV RV2 is normally set to give ~ 1.5mV change.

RV3 Voltage Range Preset 50V

With a switched to 60V 200mA range adjust RV3 for maximum output of 61V when voltage control is fully clockwise.

RV4 Voltage Range Preset 30V

Set as for RV3 on 30V 200mA range and adjust for 31.0V.

RV7 Max. Constant Current 1 Amp

Set supply to 60V 1 amp range. Output voltage to 30V Current Vernier fully clockwise. Connect external ammeter across output terminals and set RV7 to allow 1.1amps maximum reading on Ammeter.

RV8 Max. Constant Current 200mA

Set supply to 30V 200mA. Output value to 15V. Current Vernier fully clockwise. Connect external ammeter across output terminals and set RV8 to allow 210mA output current.

RV9 Max. Constant Current 2A

Set supply to 30V 2A, set as for RV8 adjust RV9 for 2.1 amps approx.

RV10 Ammeter Calibration 200mA

Set to 30V 200mA Range. Connect a known standard ammeter across the output terminals. Adjust constant current vernier to give a load current of 200mA according to external standard - adjust RV10 to set panel meter to a corresponding reading (blue calibrations).

NOTE: Current Vernier must be at maximum clockwise rotation for this adjustment.

RV11 Ammeter Calibration 2 Amps.

Set up as for RV10 and adjust RV11 for 2 Amps FSD against external standard.

8. TRANSISTOR AND DIODE ALTERNATIVES

TYPE	ALTERNATIVE	SPECIFICATION
6F15 Diode		150V PIV 3 Amp Cathode to stud.
R205 Diode	BS1/1	100V PIV200mA Wire-in
OA202 Diode	OA200	50V PIV 50mA Wire-in
BZY56 zener	BZY88-C4V7	4.7V 250mW Wire-in Zener
BZY59 zener	BZY88-C6V2	6.2V 250mW Wire-in Zener
2N3055 Transistor (NPN)	(115 Watts at 25°C)	80V Vce, hfe 50 at 2 Amps
2N3054 Transistor (NPN)	(25 Watts at 25°C)	60V Vce, hfe 50 at 1 Amp
2N3642 Transistor (NPN)	2N3053	60V Vce, hfe 50 at 10mA
2N3563 Transistor (NPN)	AY1112, BC107	30V Vce, hfe 100 at 1mA
2N3638 Transistor (PNP)	BCZ10, 11, 12	30V Vce, hfe 20 at 1mA
40250 Transistor (NPN)	2N3054	40V Vce, hfe 50 at 100mA
BC107 Transistor (NPN)	(Matched Pairs)	30V Vce, hfe 100 at 1mA

NOTE: All diodes and transistors used in this supply are high temperature Silicon components. Replacements must be silicon to obtain the same performance figures and stability.

9. REPLACEMENT PARTS

Spares are normally available from the manufacturer, B.W.D. ELECTRONICS PTY. LTD. When ordering, it is necessary to indicate the 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 B.W.D. ELECTRONICS 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 notics.

10. WARRANTY

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.

MODIFICATIONS

C11 MOVED TO INPUT SIDE OF S5 A & B
R21 CHANGED TO 1·2K 1W
D7 CATHODE MOVED TO PIN 14 OF P/C CONNECTOR
R58 ADDED (NOM. 1K Ω)

ISS. 2
CIRCUIT CORRECTIONS

ISS. 3
C7 WAS 100/64

ISS 4
C12 ADDED

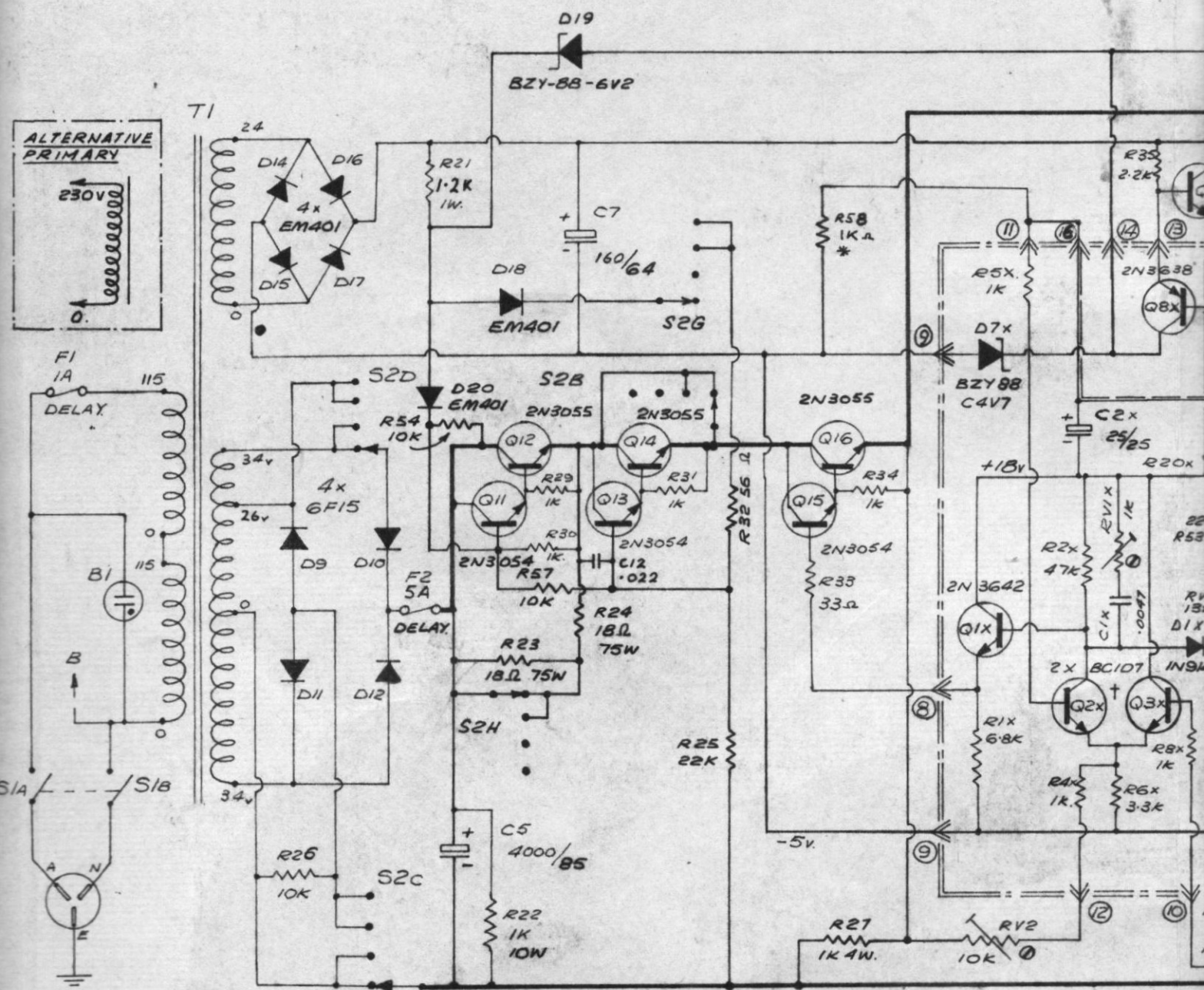
SWITCHES.

S1A&B. A.C. POWER.
S2A TO J. VOLTAGE & CURRENT RANGE. (F, G & I are not used)
S3A&B. VOLT - AMP METER RANGE.
S4. PUSH BUTTON CURRENT SET.
S5A TO D. STANDBY - USE.

ALL SWITCHES SHOWN ANTICLOCKWISE.

CONTROLS.

RV1x. H.F. OUTPUT IMPEDANCE PRESET.
RV2. OUTPUT IMPEDANCE.
RV3. OUTPUT VOLTAGE PRESET 60V
RV4. " " " 30V
RV5. OUTPUT VOLTAGE CONTROL.
RV6. " CURRENT "
RV7. SET MAX. CURRENT 1A.
RV8. " " " 200mA.
RV9. " " " 2A.
RV10. SET METER CURRENT RANGE 200mA
RV11. " " " " 2A.
RV12x. CONSTANT CURRENT OUTPUT IMPEDANCE.
RV13x. MINIMUM CURRENT PRESET. (15mA)



NOTES:

1. Q2x, Q3x, & Q6x, Q7x MATCHED PAIRS.†
2. ALL COMPONENTS WITH P.T N.OS ENDING IN "X" e.g. R4x ARE LOCATED ON P/C. BOARD.
3. * SELECTED ON TEST.
4. Ø DENOTES INTERNAL PRESET.

S2A-J LEGEND.

60V. 1A. •
60V. 200mA. •
30V. 200mA. •
30V. 2A. ⟵

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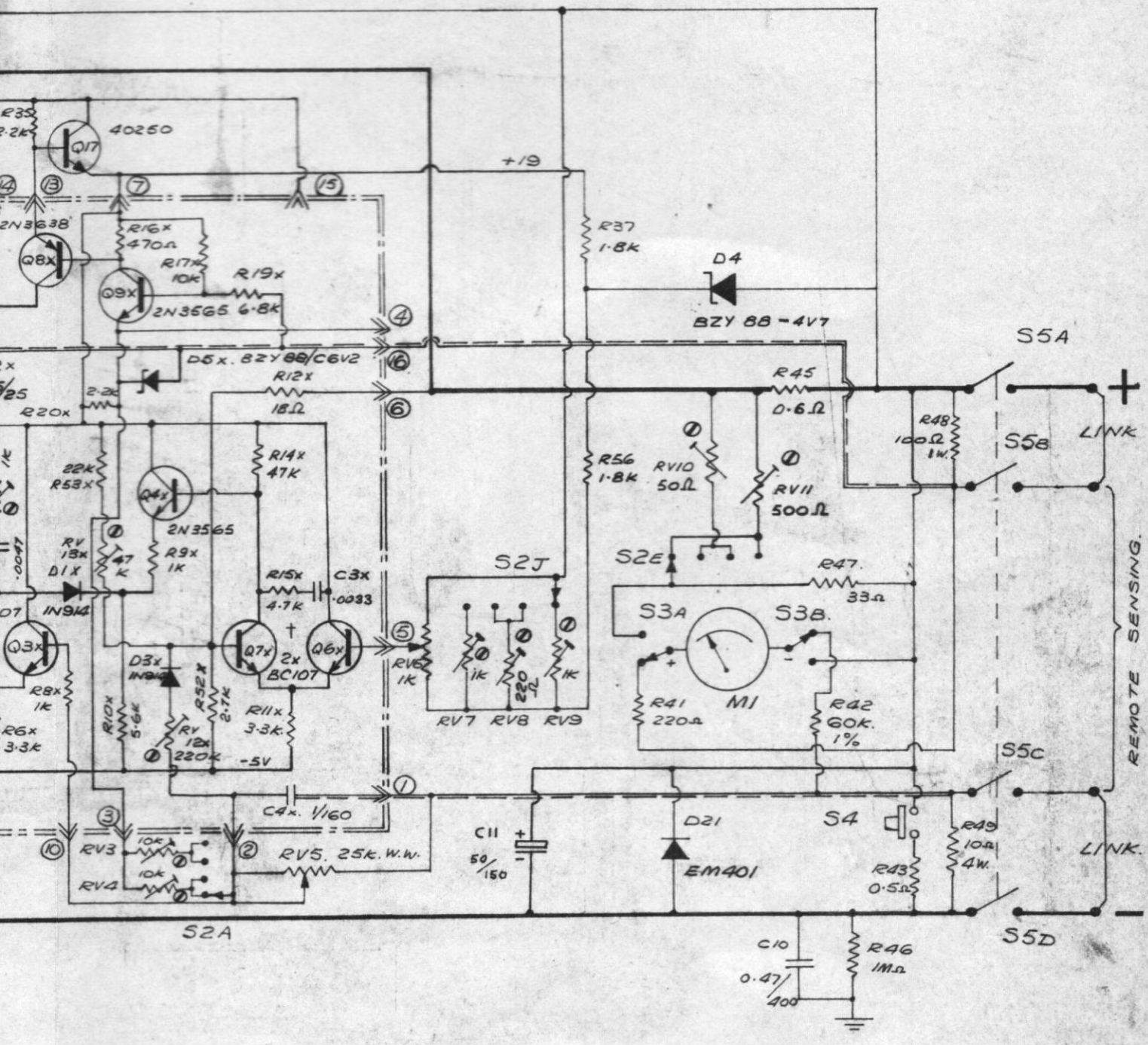

ISSUE	ISSUE		B.W.D. ELECTRONICS P/L. MELB. AUST.	DRAWING N°
4 / 4/69	1 / 4/67	DRAWN J.B. TRACED D.H.C. CHECKED 4B.	MODEL 255 STABILISED POWER SUPPLY	459A