'D.C. REGULATION' CALIBRATION PROCEDURE (OPTIONAL)

- USE A 10 OHM RESISTOR RATED FOR AT LEAST 22W, OR AN EQUIVALENT CONSTANT RESISTANCE ELECTRONIC LOAD
- 'COARSE VOLTAGE' S-1 SET TO '15V'
- 'COARSE CURRENT' S-2 SET TO '1.5A'
- 'CURRENT-VOLTAGE' S-4 SET TO 'VOLTAGE'
- 'FINE CURRENT' R5 SET TO FULL CW
- ADJUST 'FINE VOLTAGE' R31 TO ACHIEVE A READING OF 15V ON METER (FULL SCALE READING)
- REMOVE GUARD NUT FROM 'D.C. REGULATION' (DCR) R23
- OBSERVE METER WHILE ALTERNATELY CONNECTING AND DISCONNECTING LOAD FROM SUPPLY OUTPUT TERMINALS; ADJUST DCR TO ACHIEVE NO VOLTAGE READING CHANGES ON METER
- REPLACE GUARD NUT ON DCR

METER VOLTAGE SCALES

- THE 5V RANGE USES THE METER AT FULL SCALE = 5V
- THE 10V & 15V RANGES USE THE METER AT FULL SCALE = 15V
- ALL OTHER RANGES USE THE METER AT FULL SCALE = 50V

SEE 'D.C. REGULATION' CALIBRATION NOTES AT UPPER LEFT OF DRAWING

T1

CURRENT (AMBER) NE-2H R26 27k 10%

VOLTAGE (RED) NE-2H R27 27k 10%

THE POWER SWITCH IS PART OF THE 'COARSE VOLTAGE' SWITCH S-1

S-4 CURRENT 7 VOLTAGE 9 8 TO S-4 NEAR M1

1-1/2A SLO-BLO (120V) 1A SLO-BLO (240V) 3AG

105 ~ 125VAC OR 210 ~ 250VAC 50 ~ 60 Hz HOT BLK WHT NEUTRAL

BLK TJ1 YEL-BLK GRN-BLK TJ2 RED-BLK

NOTE: FOR 240V POWER, THE TWO JUMPERS TJ1 & TJ2 ARE REPLACED WITH A SINGLE JUMPER BETWEEN TRANSFORMER TERMINALS 2 & 4

YEL 7 VAC YEL

D2 1N2071 C4 250µF 25V

R4 200 5%

CURRENT LIMITER BIAS POWER SUPPLY

D7 1N2071

RELAY

R5 30 'FINE CURRENT' CW

R8 8.2 5%

CURRENT LIMITER

Q1 DTG-600

R7 10 10%

'COARSE CURRENT' S-2 CC-2

R12 0.82 2W 5% R11 2.7 2W 5% R10 15 5%

1.5A 500 mA 150 mA 50 mA

'COARSE VOLTAGE' S-1 CV-4FR

RED-GRN GRN-BLK RED-BLK GRY YEL-BLU YEL-RED YEL-GRN YEL-BLK GRN BLU ORG

50V 45V 40V 35V 30V 25V 20V 15V 10V 5V OFF

MAIN SUPPLY

D3 1N2071 D4 1N2071 D5 1N2071 D6 1N2071

C5 3000µF 75V R6 6.8k 2W

CURRENT METER SHUNT

'COARSE CURRENT' S-2 CC-1

1.5A 500 mA 150 mA 50 mA

R21 0.1 1% R20 0.2 1% R19 0.7 1% R18 2 1% R17 97 1%

R23 50 'D.C. REGULATION' CW

R24 0.33 2W 5%

R25 1.2k 5%

D8 1N2071

C7 0.01µF 50V R22 150k 10%

Q2 2N2553/R265A

ERROR DETECTOR

R15 2.7k 10%

R28 4.7k 10%

Q3 2N2553/R265A

ERROR AMPLIFIER

SERIES REGULATORS

R29 500 OHM 50'C

Q4 2N2869 Q5 2N2869

R51 0.33 2W 5%

R52 0.33 2W 5%

VR-56 1.5W

0.015µF 600V

HEATHKIT RECOMMENDED RETROFIT – NOT PART OF ORIGINAL KIT – SEE NOTE 5

C8 100µF 50V

R30 1.2k 5% RELAY 7V COIL

C9 500µF 50V

S-5 'RESET-STANDBY' 1 DC ON 2 STANDBY

RED BLK

C10 0.2µF 200V

SEE NOTE ABOVE

R53 4.95k 1% R54 10k 1% R55 35k 1%

S-1 CV-1F OFF 5V 10V 15V 20V 25V 30V 35V 40V 45V 50V

VOLTAGE METER SERIES RESISTOR

S-1 CV-1R 'COARSE VOLTAGE'

8x 200 5%

'COARSE VOLTAGE' S-1 CV-2F 50V 45V 40V 35V 30V 25V 20V 15V 10V 5V OFF

R41 R40 R39 R38 R37 R36 R35 R34 R33 160 5%

R31 240 'FINE VOLTAGE' CW

REFERENCE VOLTAGE DIVIDER

'COARSE VOLTAGE' S-1 CV-3R OFF 5V 10V 15V 20V 25V 30V 35V 40V 45V 50V

R42 160 5% R43 R44 R45 R46 R47 R48 R49 R50

8x 200 5%

R14 1k 'VOLTAGE CALIBRATE' CW

REFERENCE VOLTAGE SUPPLY

RED 170 VAC RED

D1 1N2071

C1 100µF 250V R1 2.5k 7W 5% R2 1.2k 2W 5%

Z1 VR-110 5W Z3 VR-68 1.5W

C2 40µF 250V C3 40µF 200V

R3 1k 'ZENER CURRENT ADJUST' CW

CAPACITORS C1, C2, C3 ARE ALL IN A SINGLE CAN BUT MAY BE REPLACED WITH SEPARATE CAPACITORS

C6 100µF 10V R9 200 5%

R13 15 5%

Z2 VR-56 1.5W

CURRENT 4 6 1 VOLTAGE 3 TO S-4 NEAR T1 5 2 S-4

NORMAL 9 3 8 2 7 ZERO CURRENT 1 S-3 6 5 4 M1 1mA, 50 OHM

R32 10 10%

METER SWITCHING

CALIBRATION PROCEDURE

- 'COARSE CURRENT' S-2 SET TO '1.5A'
- 'FINE CURRENT' R5 SET TO FULL CW
- 'D.C. REGULATION' R23 SET TO 1/8 TURN CCW FROM FULL CW
- METER 'CURRENT-VOLTAGE' S-4 SET TO 'VOLTAGE'
- 'ZENER CURRENT ADJUST' R3 SET TO FULL CCW
- 'VOLTAGE CALIBRATE' R14 SET TO CENTER OF ROTATION
- METER 'NORMAL-ZENER CURRENT' S-3 SET TO 'ZENER CURRENT'
- ADJUST 'ZENER CURRENT ADJUST' R3 FOR A METER READING OF 5mA (METER FULL SCALE)
- METER 'NORMAL-ZENER CURRENT' S-3 SET TO 'NORMAL'
- 'RESET-STANDBY' S-5 SET TO 'ON'
- 'COARSE VOLTAGE' S-1 SET TO '50V'
- 'FINE VOLTAGE' R31 SET TO FULL CW
- ADJUST 'VOLTAGE CALIBRATE' R14 FOR A METER READING OF '50V' (METER FULL SCALE)

SEMICONDUCTOR REPLACEMENT TABLE

HEATHKIT PART NUMBER	GENERIC PART NUMBERS FIRST	SECOND	THIRD	LIMITED SPECIFICATIONS
57-27	1N2071	1N4005	1N5397	SILICON DIODE, 600PIV, 1A (1N5397 IS 1.5A)
56-13 (VR-56)	1N5943A	1N5231B	1N5370A	56V ZENER DIODE, 1.5W
56-68 (VR-68)	ZVR-68	1N5945A	1N5373A	68V ZENER DIODE, 1.5W
56-48 (VR-110)	BTZ-110A	1N3814	1N5379B	110V ZENER DIODE, 15mA, 5W
417-20	2N2553	R265A	2N1039-1	GERMANIUM PNP TRANSISTOR, 40V, 3A, STR-10
417-141	2N2869	2N301		GERMANIUM PNP TRANSISTOR, 50V, 10A, 30W, TO-3
417-142	DTG-600			GERMANIUM PNP TRANSISTOR, 50V, 50A, 60W, TO-3/TO-204

'FIRST' & 'SECOND' PART NUMBERS ARE HEATHKIT'S RECOMMENDATIONS, 'THIRD' PART NUMBER SHOULD WORK

NOTES:

1) RESISTORS ARE 1/2W UNLESS MARKED DIFFERENTLY. % TOLERANCES ARE SHOWN FOR ALL.
2) ALL POTENTIOMETERS ARE WIRE-WOUND TYPE.
3) THE HEATHKIT MANUAL DOES NOT SPECIFY CAPACITOR VOLTAGES; VOLTAGES SHOWN HERE ARE EITHER AS MARKED ON THE ACTUAL PARTS, OR ARE REASONABLE GUESSES.
4) HEATHKIT PRODUCED MULTIPLE VERSIONS OF THE SCHEMATIC DIAGRAM FOR THE IP-27. THERE ARE SOME SMALL DISCREPANCIES BETWEEN THEM; AN EFFORT HAS BEEN MADE TO HAVE THIS SCHEMATIC BE REPRESENTATIVE OF LATER REVISIONS OF THE PRODUCT.
5) THIS SCHEMATIC INCORPORATES AN ADDITIONAL TWO COMPONENTS WHICH WERE RECOMMENDED BY HEATHKIT AS A RETROFIT; THE IP-27 WAS SUBJECT TO HAVING ITS OUTPUT (SERIES PASS) TRANSISTORS, AND/OR THEIR DRIVER (ERROR AMPLIFIER) TRANSISTOR, DAMAGED IF THE USER CHANGED THE 'COARSE VOLTAGE' SWITCH TOO RAPIDLY THROUGH MULTIPLE POSITIONS, AND THE RETROFITTED COMPONENTS SHUNT THE POTENTIALLY DAMAGING VOLTAGE TRANSIENTS. THIS IS PER HEATHKIT SERVICE BULLETIN IP-27-1, DATED JUNE 1971.
6) THE POSITIONS OF THE 'COARSE VOLTAGE' SWITCH S-1 REPRESENT THE HIGHEST VOLTAGE FOR THE SELECTED RANGE, WITH THE LOWEST VOLTAGE IN THE RANGE BEING ABOUT 6V LOWER, e.g. THE '45V' RANGE SPANS ABOUT 39V ~ 45V, OR A BIT HIGHER.
7) THE ROTARY SWITCHES ARE REPRESENTED HERE 'STRAIGHTENED OUT'. THE TOGGLE SWITCH AND THE ROCKER SWITCHES ARE SHOWN HERE USING TRADITIONAL BASIC SYMBOLOGY.
8) THE HEATHKIT CODE FOR IDENTIFICATION OF THE SELECTOR SWITCH WAFERS IS AS FOLLOWS: THE PREFIX 'CV' MEANS THAT THE SWITCH WAFER IS PART OF THE 'COARSE VOLTAGE' SWITCH, WHILE THE PREFIX 'CC' MEANS THAT THE SWITCH WAFER IS PART OF THE 'COARSE CURRENT' SWITCH. THE NUMERICAL DIGIT THAT FOLLOWS THE PREFIX REFERS TO THE WAFER, WITH WAFER 1 BEING THE ONE CLOSEST TO THE FRONT PANEL, AND HIGHER WAFER NUMBERS BEING PROGRESSIVELY FURTHER FROM THE FRONT PANEL. THE LETTER SUFFIX 'F' REFERS TO THE FRONT SIDE OF THE WAFER (FRONT BEING CLOSER TO THE FRONT PANEL), 'R' REFERS TO THE REAR SIDE OF THE WAFER, AND 'FR' REFERS TO A WAFER THAT HAS RELATED CONTACT ELEMENTS ON BOTH ITS FRONT AND REAR SIDES.
9) THE IP-27 IS ALMOST ENTIRELY THE SAME CIRCUIT AS THE EARLIER IP-20, EXCEPT WITH A DIFFERENT CASE DESIGN. OTHER DIFFERENCES ARE THAT THE FUNCTIONALITY OF THE 110V AND 68V ZENER DIODES (Z1 & Z3 ON THIS SCHEMATIC) IN THE REFERENCE VOLTAGE SUPPLY OF THE IP-27 WERE HANDLED BY A SINGLE OB2 REGULATOR TUBE IN THE IP-20, THE IP-20 DID NOT HAVE TWO TRANSFORMER PRIMARY WINDINGS TO ALLOW 120V & 240V OPERATION, COMPONENT DESIGNATIONS WERE ENTIRELY DIFFERENT, THE NUMBERING OF SWITCH TERMINALS WAS DIFFERENT, AND THE IP-20 DID NOT HAVE THE TWO NEON INDICATORS (AND ASSOCIATED RESISTORS) TO HIGHLIGHT WHETHER THE METER WAS IN CURRENT OR VOLTAGE MODE. COMPONENT VALUES ARE THE SAME BETWEEN THE TWO MODELS. THE AUTHOR OF THIS SCHEMATIC HAS ALSO PREPARED A SEPARATE IP-20 SCHEMATIC.
10) THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A LEGIBLE AND MORE EASILY UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IP-27. AN EFFORT HAS BEEN MADE TO SIZE AND SCALE COMPONENTS AND TEXT FOR THE LARGEST AND BEST VISIBILITY AND LEGIBILITY WHILE STILL FITTING ON A NORMAL 11 X 17" SHEET OF PAPER. ALL COMPONENT VALUES AND DESIGNATIONS, TERMINALS, AND WIRE COLORS ARE SHOWN AS VERIFIED BY EXAMINATION OF A BUILT AND WORKING IP-27 POWER SUPPLY.
11) THE COPYRIGHT HOLDER HEREBY GIVES PERMISSION TO FREELY DISTRIBUTE THIS DOCUMENT, AS LONG AS NO ALTERATIONS ARE MADE AND CREDIT IS GIVEN, ALONG WITH THE COPYRIGHT NOTICE.

THE IP-27 HAS TWO MODES OF OVER-CURRENT PROTECTION:

– THE PRIMARY MODE IS SOLID STATE CURRENT LIMITING, WHEN THE OUTPUT CURRENT FLOWING THROUGH THE 'FINE CURRENT' POTENTIOMETER R5 AND ASSOCIATED SHUNT RESISTORS IS SUFFICIENT TO GENERATE ENOUGH VOLTAGE DROP AT THE WIPER OF R5 THAT THE DIODE D7 IS FORWARDED BIASED, IN WHICH CASE LIMITER BIAS SUPPLY IS SHUNTED, BYPASSING THE BASE-EMITTER JUNCTION OF TRANSISTOR Q1 SO THAT IT COMES OUT OF SATURATION, THUS INCREASING ITS RESISTANCE TO THE FLOW OF THE OUTPUT CURRENT.

– IF A SHORT CIRCUIT OR A VERY LOW RESISTANCE LOAD IS CONNECTED TO THE OUTPUT, THE + AND – OUTPUT TERMINALS ARE NEARLY AT THE SAME POTENTIAL, AND SINCE THE OUTPUT – TERMINAL AND THE – SIDE OF THE REFERENCE VOLTAGE SUPPLY ARE COMMON, THE WIPER OF 'FINE VOLTAGE' POTENTIOMETER R31, WHICH IS BASED ON THE REFERENCE SUPPLY VOLTAGE, WILL NOW BE POSITIVE IN RELATION TO THE SUPPLY'S + OUTPUT, THUS FORWARD BIASING D8 WHICH THEN ALLOWS SUFFICIENT CURRENT TO FLOW FROM THE + SIDE OF THE REFERENCE SUPPLY, THROUGH THE RELAY COIL AND D8, AND THEN THROUGH THE LOW AND BACK TO THE – OUTPUT TERMINAL (COMMON TO THE REFERENCE SUPPLY'S – SIDE), AND SUCH CURRENT THEN DEVELOPS 7 VOLTS ACROSS THE RELAY COIL, ACTUATING THE RELAY AND OPENING THE NORMALLY CLOSED RELAY CONTACTS, DISCONNECTING THE VOLTAGE SOURCE FROM THE + OUTPUT. AS LONG AS THE LOW RESISTANCE LOAD REMAINS CONNECTED, THE RELAY WILL KEEP THE SUPPLY DISCONNECTED FROM THE OUTPUT. OPENING THE 'RESET-STANDBY' SWITCH, OR DISCONNECTING THE LOAD, WILL ALLOW THE RELAY TO DE-ENERGIZE, RECONNECTING THE SUPPLY TO THE + OUTPUT.

REVISION A 4-23-2021

HEATHKIT
DC POWER SUPPLY IP-27
SCHEMATIC DIAGRAM