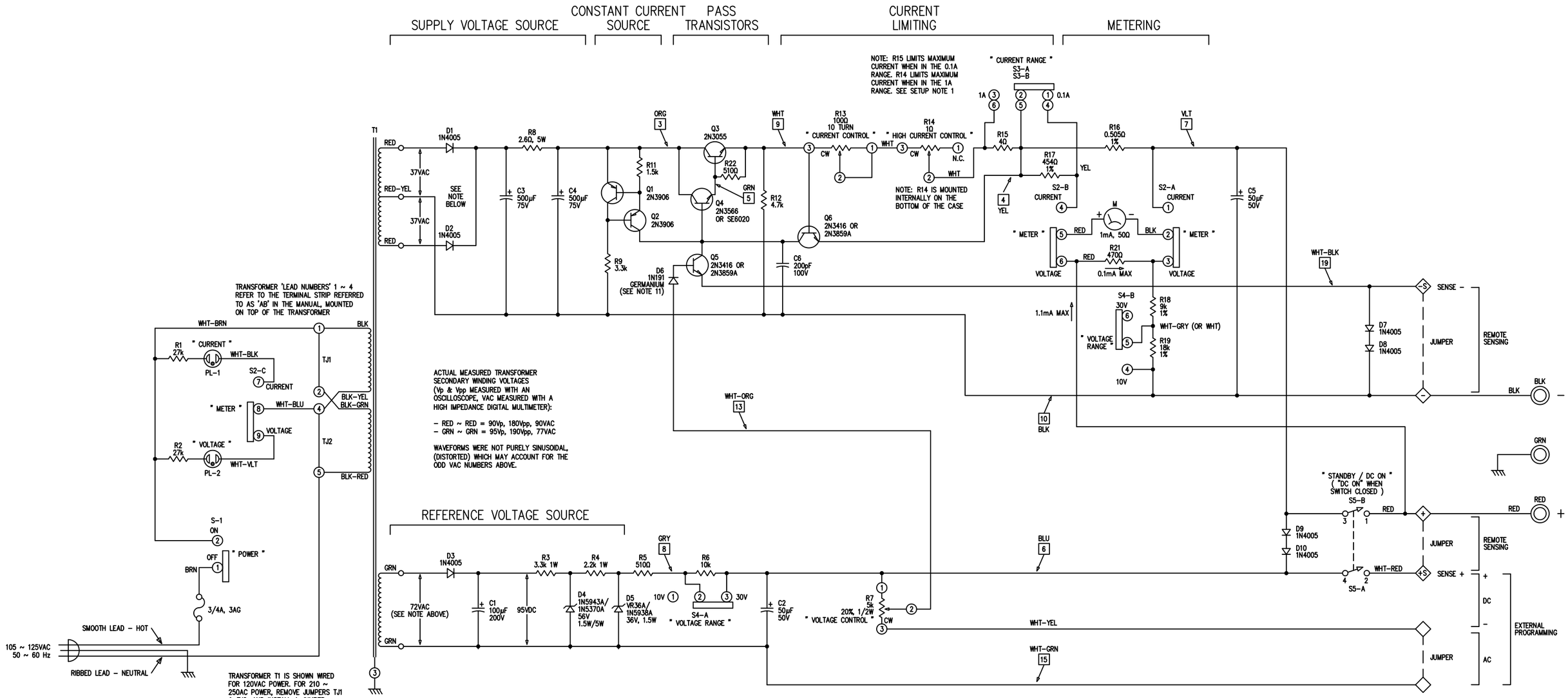


SETUP NOTES:

1) THE ONLY CALIBRATION ON THE POWER SUPPLY IS "HIGH CURRENT CONTROL" R14, AS FOLLOWS:
   - SET R14 FULLY COUNTER-CLOCKWISE
   - SET CURRENT SWITCH TO 1A RANGE
   - SET VOLTAGE SWITCH TO 30V RANGE
   - SET METER SWITCH TO 'VOLTAGE'
   - USE "VOLTAGE CONTROL" TO SET OUTPUT VOLTAGE TO 30V AS READ ON THE METER ("STANDBY" SWITCH MUST BE 'ON' WHILE DOING THIS)
   - SET METER SWITCH TO 'CURRENT'
   - SHORT THE + & – OUTPUT TERMINALS TOGETHER WITH A JUMPER (POWER SUPPLY WILL NOT BE DAMAGED)
   - TURN R14 CLOCKWISE UNTIL METER READS 1A ('10' ON THE METER SCALE, i.e. FULL SCALE)
   - REMOVE SHORT CIRCUIT JUMPER
2) NORMALLY, THE "CURRENT CONTROL" R13 SHOULD BE SET FULLY CLOCKWISE; THIS IS A 10-TURN POTENTIOMETER, AND FULL CLOCKWISE CANNOT BE SEEN, SO TURN CLOCKWISE UNTIL INCREASED RESISTANCE IS FELT. IF IT IS DESIRED TO HAVE THE POWER SUPPLY LIMIT THE MAXIMUM OUTPUT CURRENT, i.e. 'CURRENT LIMITING', TURN THE "CURRENT CONTROL" R13 COUNTER-CLOCKWISE TO SET MAXIMUM CURRENT. THIS MAY BE DONE BY MORE THAN ONE METHOD, EXAMPLES BELOW:
   - A COMMON METHOD IS TO SET THE DESIRED VOLTAGE, CONNECT THE POWER SUPPLY TO THE LOAD, SET THE METER TO READ VOLTAGE, AND TURN THE "CURRENT CONTROL" COUNTER-CLOCKWISE UNTIL THE METER SHOWS THE VOLTAGE JUST BEGINNING TO DECREASE, THEN TURN IT BACK SLIGHTLY CLOCKWISE TO RESTORE THE DESIRED VOLTAGE. NOW, IF THE LOAD SHOULD TRY TO INCREASE, THE POWER SUPPLY WILL AUTOMATICALLY REDUCE THE OUTPUT VOLTAGE TO HOLD THE OUTPUT CURRENT AT THE SET LIMIT.
   - ANOTHER COMMON METHOD IS TO SET THE METER TO READ VOLTAGE, TURN "CURRENT CONTROL" & "VOLTAGE CONTROL" FULLY COUNTER-CLOCKWISE, SET SWITCH TO "ON", ADJUST "VOLTAGE CONTROL" AS REQUIRED TO THE DESIRED 'VOLTAGE PRESET', SET SWITCH TO "STANDBY", CONNECT LOAD, SET SWITCH TO "ON". DISPLAYED VOLTAGE WILL BE LOW; TURN "CURRENT CONTROL" CLOCKWISE UNTIL JUST PAST THE POINT WHERE VOLTAGE PRESET IS OBTAINED AGAIN.
   - IF WHEN LOAD CURRENT TRIES TO INCREASE, THE POWER SUPPLY SUDDENLY DROPS THE OUTPUT VOLTAGE, RATHER THAN GRADUALLY REDUCING THE VOLTAGE, THIS IS LIKELY CAUSED BY A DEFECTIVE Q6 TRANSISTOR.

NOTES:

1) RESISTORS ARE 1/2W, 10% UNLESS MARKED DIFFERENTLY.
2) NUMBERS IN SQUARE BOXES, WITH ARROWS POINTING TO WIRING, REFER TO NUMBERED HOLES IN THE PRINTED CIRCUIT BOARD.
3) NUMBERS IN DIAMOND OUTLINES ARE THE "SENSING / PROGRAMMING" TERMINALS ON THE REAR OF THE POWER SUPPLY.
4) ROUND TERMINALS WITH MARKINGS INSIDE LARGE CIRCLES ◯ ARE FOR THE TERMINAL STRIP MOUNTED ON TOP OF THE TRANSFORMER FOR PRIMARY WINDING WIRES.
5) ROUND TERMINALS WITHOUT MARKINGS INSIDE SMALL CIRCLES ○ ARE PRINTED CIRCUIT BOARD HOLES FOR TRANSFORMER SECONDARY WINDING WIRES.
6) SOME VERSIONS OF THE ORIGINAL HEATHKIT SCHEMATIC SHOW ERRONEOUS CONNECTIONS AROUND Q3 & R22, SUCH THAT R22 IS CONNECTED ACROSS THE COLLECTOR AND EMITTER OF Q3 RATHER THAN THE CORRECT CONNECTION ACROSS THE BASE AND EMITTER. THIS REDRAWN SCHEMATIC SHOWS THE CORRECT CIRCUIT AS VERIFIED ON AN ACTUAL BUILT AND WORKING IP-28 POWER SUPPLY.
7) SOME VERSIONS OF THE ORIGINAL HEATHKIT SCHEMATIC SHOW R14 AS A FIXED RESISTOR RATHER THAN A POTENTIOMETER. SOME VERSIONS SHOW R14 TERMINAL 1 JUMPERED TO TERMINAL 2 (TERMINAL 2 REMAINING CONNECTED AS SHOWN HERE); THIS DOES NOT AFFECT FUNCTIONALITY.
8) SOME VERSIONS OF THE ORIGINAL HEATHKIT SCHEMATIC SHOW Q4, Q5, Q6 WITH THE SECOND PART NUMBERS SHOWN ABOVE.
9) SOME VERSIONS OF THE ORIGINAL HEATHKIT SCHEMATIC OMIT C6, OR SHOW IT BUT WITH A VALUE OF 200uF RATHER THAN THE CORRECT VALUE OF 200pF; THIS IS A CERAMIC DISK CAPACITOR.
10) FOR D4 & D5, THE SECOND LISTED PART NUMBER IS THE BETTER CHOICE.
11) FOR D6, 1N191 DIRECT REPLACEMENT IS NTE109. POSSIBLE ALTERNATE PARTS (UNPROVEN) ARE 1N5711, 1N34A.
12) IN ORDER FOR THE REGULATED SUPPLY TO FUNCTION, THERE MUST BE A COMMON REFERENCE POINT BETWEEN THE 'REFERENCE VOLTAGE SOURCE' AND THE MAIN VOLTAGE REGULATOR CIRCUIT; THE SIGNAL COMING FROM THE WIPER OF R7 IS IN REFERENCE TO THIS COMMON REFERENCE POINT, WHICH IS NORMALLY THE CONNECTION BETWEEN THE (+) SIDES OF EACH SUPPLY, MADE VIA THE JUMPER BETWEEN THE <+> AND <+S> REMOTE SENSING TERMINALS (WHEN THE "STANDBY/ON" SWITCH IS IN THE "ON" POSITION). THE MAIN REGULATOR CIRCUIT MAY NOT INTERNALLY REGULATE TO THE DESIRED VOLTAGE IF REMOTE SENSING IS DEFEATED OR OPEN, OR WHEN THE SWITCH IS IN THE "STANDBY" POSITION.
13) THE PRINTED CIRCUIT BOARD'S NUMBERED HOLES DO NOT INCLUDE 1, 2, 11, 12, 14, 16, 17, 18, 20.
14) THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A LEGIBLE SCHEMATIC FOR THE HEATHKIT IP-28. 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, WIRE COLORS, AND PRINTED CIRCUIT BOARD HOLES ARE SHOWN AS VERIFIED BY EXAMINATION OF A BUILT AND WORKING IP-28 POWER SUPPLY (PRECISION RESISTORS SHOWN HERE AS 1% WERE NOT ALWAYS MARKED WITH A TOLERANCE, BUT THEIR FUNCTION IN THIS CIRCUIT STRONGLY SUGGESTS THE CLOSER TOLERANCE).
15) 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.

REMOTE SENSING & PROGRAMMING:

1) THE POWER SUPPLY CAN OPTIONALLY BE WIRED TO SENSE THE REGULATED VOLTAGE AT THE LOAD RATHER THAN AT THE OUTPUT TERMINALS. AT THE TERMINAL BOARD ON THE REAR PANEL OF THE POWER SUPPLY, LOOSEN THE FOUR SCREWS AT THE (–), (–S), (+), (+S) POSITIONS, AND SWING THE TWO JUMPERS AWAY FROM THE (–) AND (+S) POSITIONS, EFFECTIVELY REMOVING THOSE JUMPERS FROM THE CIRCUIT. CONNECT THE (–) & (+) POSITIONS TO THE LOAD USING HEAVIER GAUGE WIRES SUITABLE FOR THE RATED 1A CURRENT, OR ALTERNATELY USE THE NORMAL + AND – TERMINALS ON THE FRONT OF THE POWER SUPPLY FOR THIS PURPOSE, AS THEY ARE ELECTRICALLY COMMON. CONNECT TWO OTHER WIRES COMING BACK FROM THE LOAD (THE 'SENSE WIRES') TO THE REAR TERMINALS, WITH THE (–S) TERMINAL CONNECTED TO THE – SIDE OF THE LOAD AND THE (+S) TERMINAL CONNECTED TO THE + SIDE OF THE LOAD. THIS ARRANGEMENT WILL ALLOW OPTIMAL VOLTAGE REGULATION. IF THE SUPPLY IS TURNED ON WITH THE TWO JUMPERS OPEN AND THE TWO 'SENSE' WIRES NOT CONNECTED TO THE LOAD, THE OUTUT VOLTAGE WILL RISE UNTIL LIMITED BY THE ACTION OF DIODES D7 ~ D10.
2) FOR DC PROGRAMMING, REMOVE THE JUMPER THAT IS NORMALLY BETWEEN THE TWO REAR PANEL TERMINAL BOARD'S "AC" POSITIONS; THIS DISCONNECTS THE INTERNAL REFERENCE VOLTAGE FROM THE POWER SUPPLY'S REGULATOR CIRCUIT. CONNECT THE EXTERNAL DC VOLTAGE SOURCE TO THE TERMINAL BOARD'S "DC" POSITIONS, OBSERVING THE + & – POLARITY. THE POWER SUPPLY OUTPUT WILL NOW FOLLOW THE EXTERNAL DC PROGRAMMING VOLTAGE, UP TO THE MAXIMUM VOLTAGE LIMIT OF ABOUT 30VDC.
3) FOR AC PROGRAMMING, REMOVE THE JUMPER THAT IS NORMALLY BETWEEN THE TWO REAR PANEL TERMINAL BOARD'S "AC" POSITIONS; THIS DISCONNECTS THE INTERNAL REFERENCE VOLTAGE FROM THE POWER SUPPLY'S REGULATOR CIRCUIT. CONNECT THE EXTERNAL AC VOLTAGE SOURCE TO THESE SAME TWO TERMINAL POSITIONS. THE AC SIGNAL SOURCE MUST HAVE A LOW IMPEDANCE, SUCH AS THE SECONDARY OF A POWER TRANSFORMER; A HIGHER IMPEDANCE SOURCE PROBABLY WILL NOT WORK WELL. THE POWER SUPPLY'S "VOLTAGE CONTROL" WILL SET THE AVERAGE DC VOLTAGE OF THE RESULTING PULSATING DC OUTPUT VOLTAGE.

# HEATHKIT
# DC POWER SUPPLY IP-28
# SCHEMATIC DIAGRAM

REVISION D 2-27-2021