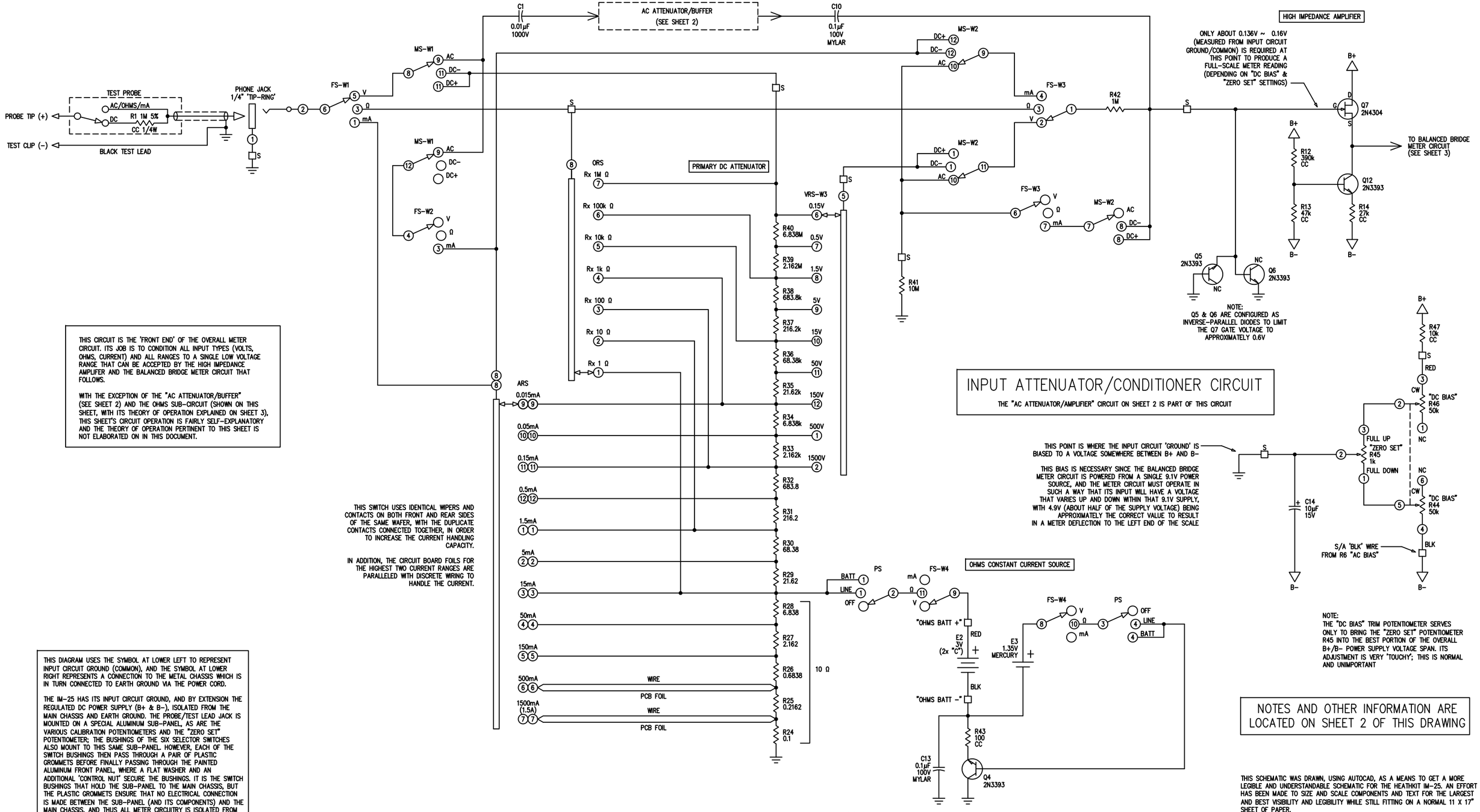


THIS CIRCUIT IS THE 'FRONT END' OF THE OVERALL METER CIRCUIT. ITS JOB IS TO CONDITION ALL INPUT TYPES (VOLTS, OHMS, CURRENT) AND ALL RANGES TO A SINGLE LOW VOLTAGE RANGE THAT CAN BE ACCEPTED BY THE HIGH IMPEDANCE AMPLIFER AND THE BALANCED BRIDGE METER CIRCUIT THAT FOLLOWS.

WITH THE EXCEPTION OF THE "AC ATTENUATOR/BUFFER" (SEE SHEET 2) AND THE OHMS SUB-CIRCUIT (SHOWN ON THIS SHEET, WITH ITS THEORY OF OPERATION EXPLAINED ON SHEET 3), THIS SHEET'S CIRCUIT OPERATION IS FAIRLY SELF-EXPLANATORY AND THE THEORY OF OPERATION PERTINENT TO THIS SHEET IS NOT ELABORATED ON IN THIS DOCUMENT.

THIS SWITCH USES IDENTICAL WIPERS AND CONTACTS ON BOTH FRONT AND REAR SIDES OF THE SAME WAFER, WITH THE DUPLICATE CONTACTS CONNECTED TOGETHER, IN ORDER TO INCREASE THE CURRENT HANDLING CAPACITY.

IN ADDITION, THE CIRCUIT BOARD FOILS FOR THE HIGHEST TWO CURRENT RANGES ARE PARALLELED WITH DISCRETE WIRING TO HANDLE THE CURRENT.

THIS DIAGRAM USES THE SYMBOL AT LOWER LEFT TO REPRESENT INPUT CIRCUIT GROUND (COMMON), AND THE SYMBOL AT LOWER RIGHT REPRESENTS A CONNECTION TO THE METAL CHASSIS WHICH IS IN TURN CONNECTED TO EARTH GROUND VIA THE POWER CORD.

THE IM-25 HAS ITS INPUT CIRCUIT GROUND, AND BY EXTENSION THE REGULATED DC POWER SUPPLY (B+ & B–), ISOLATED FROM THE MAIN CHASSIS AND EARTH GROUND. THE PROBE/TEST LEAD JACK IS MOUNTED ON A SPECIAL ALUMINUM SUB-PANEL, AS ARE THE VARIOUS CALIBRATION POTENTIOMETERS AND THE "ZERO SET" POTENTIOMETER; THE BUSHINGS OF THE SIX SELECTOR SWITCHES ALSO MOUNT TO THIS SAME SUB-PANEL. HOWEVER, EACH OF THE SWITCH BUSHINGS THEN PASS THROUGH A PAIR OF PLASTIC GROMMETS BEFORE FINALLY PASSING THROUGH THE PAINTED ALUMINUM FRONT PANEL, WHERE A FLAT WASHER AND AN ADDITIONAL 'CONTROL NUT' SECURE THE BUSHINGS. IT IS THE SWITCH BUSHINGS THAT HOLD THE SUB-PANEL TO THE MAIN CHASSIS, BUT THE PLASTIC GROMMETS ENSURE THAT NO ELECTRICAL CONNECTION IS MADE BETWEEN THE SUB-PANEL (AND ITS COMPONENTS) AND THE MAIN CHASSIS, AND THUS ALL METER CIRCUITRY IS ISOLATED FROM CHASSIS AND EARTH GROUND. AN AC-ONLY CONNECTION IS MADE VIA 0.005µF CAPACITOR 'C17' BETWEEN THE METER'S 'B–' POWER SUPPLY RAIL AND THE MAIN CHASSIS; FOR DC SIGNALS, THIS CAPACITOR'S REACTANCE IS PRACTICALLY INFINITE, AND AT AN AC SIGNAL OF 60Hz, THE REACTANCE IS ABOUT 530 kΩ.

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEET 2 OF THIS DRAWING

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IM-25. 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.

HEATHKIT IM-25 SOLID STATE VOM SCHEMATIC DIAGRAM

SHEET 1 OF 4

REVISION A 3-25-2023

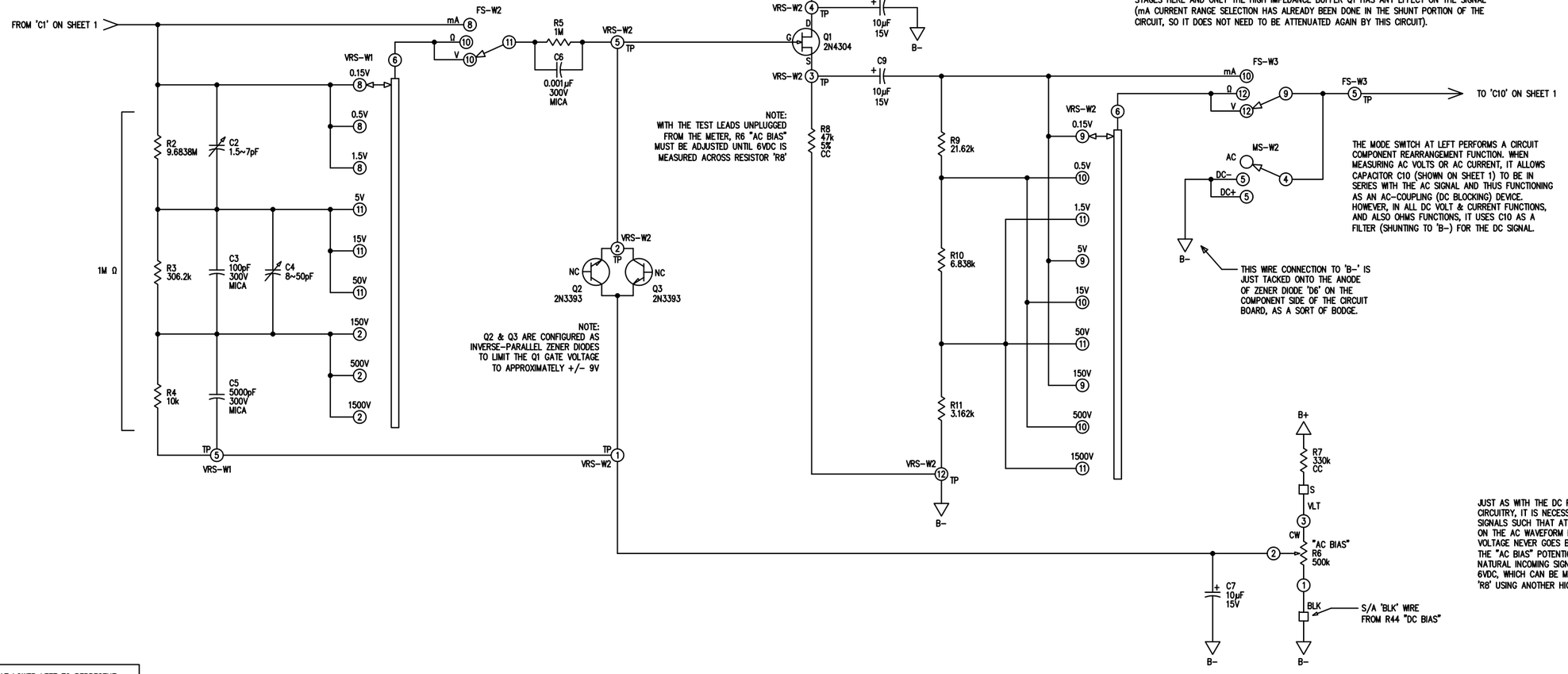
AC ATTENUATOR/BUFFER

THIS CIRCUIT IS DIVIDED INTO THREE SECTIONS: FIRST STAGE ATTENUATOR, HIGH IMPEDANCE BUFFER, AND SECOND STAGE ATTENUATOR. IN THE LOWEST THREE VOLTAGE RANGES, THE FIRST STAGE ATTENUATOR DOES NOT ATTENUATE AT ALL, AND SIMPLY PASSES THE SIGNAL THROUGH UNCHANGED. BUT THE HIGH IMPEDANCE BUFFER (Q1) CANNOT HANDLE SIGNAL VOLTAGES ANY HIGHER THAN THOSE THREE LOW RANGES, SO FOR HIGHER VOLTAGE RANGES THE FIRST STAGE ATTENUATOR REDUCES THE INPUT VOLTAGE TO LEVELS THAT Q1 CAN WORK WITH. CAPACITORS ARE USED FOR COMPENSATION AT HIGHER SIGNAL FREQUENCIES THAT THE IM-25 IS CAPABLE OF MEASURING. NOTE THAT RANGES 5V, 15V, AND 50V ALL GET A THE SAME AMOUNT OF ATTENUATION, WHILE THE HIGHEST RANGES, 150V, 500V, AND 1500V, GET THE SAME HIGHER AMOUNT OF ATTENUATION. THE SECOND STAGE ATTENUATOR WORKS WITHIN THESE THREE RANGES OF FIRST STAGE ATTENUATION.

THE HIGH IMPEDANCE BUFFER BELOW IS COMPRISED SIMPLY OF FET SOURCE FOLLOWER Q1 AND RESISTOR R8. ITS EXTREMELY HIGH INPUT IMPEDANCE ALLOWS HIGH VALUE RESISTANCES IN THE FIRST STAGE ATTENUATOR, SO THAT MINIMUM LOADING IS PRESENTED TO THE CIRCUIT UNDER TEST.

WITH THE INPUT SIGNAL ATTENUATED BY THE FIRST STAGE ATTENUATOR AND BUFFERED BY THE HIGH INPUT IMPEDANCE AND LOW OUTPUT IMPEDANCE OF Q1, THE SECOND STAGE ATTENUATOR BELOW BRINGS ALL VOLTAGE RANGES INTO A COMMON LOW VOLTAGE RANGE THAT THE HIGH IMPEDANCE AMPLIFIER Q7 (SEE SHEET 1), WHICH DRIVES THE BALANCED BRIDGE METER CIRCUIT, CAN WORK WITH. THIS ATTENUATOR'S RESISTANCE VALUES ARE RELATIVELY LOW, AND THIS DOES NOT PRESENT A PROBLEM BECAUSE THEY ARE BEING DRIVEN BY THE MUCH LOWER OUTPUT IMPEDANCE OF BUFFER Q1. BECAUSE THE FIRST STAGE ATTENUATOR REDUCES INPUT VOLTAGES IN THREE BROAD STAGES, THIS SECOND STAGE ATTENUATOR REDUCES IN ONLY THREE LEVELS, EACH WITHIN THE THREE PRECEEDING STAGES OF ATTENUATION. THE OVERALL RESULT IS FUNCTIONALLY THE SAME AS IF A SIMPLE SINGLE STAGE OF ATTENUATION FOR ALL AC VOLTAGE RANGES HAD BEEN USED.

NOTE THAT, WHILE AC CURRENT (mA) HAS ITS RELATED VOLTAGE SIGNALS (RESULTING FROM THE VOLTAGE DROP ACROSS THE SHUNT RESISTORS WHICH THE CURRENT BEING MEASURED FLOWS THROUGH) PASSING THROUGH THIS AC ATTENUATOR CIRCUIT, SWITCHES BYPASS THE ATTENUATION STAGES HERE AND ONLY THE HIGH IMPEDANCE BUFFER Q1 HAS ANY EFFECT ON THE SIGNAL (mA CURRENT RANGE SELECTION HAS ALREADY BEEN DONE IN THE SHUNT PORTION OF THE CIRCUIT, SO IT DOES NOT NEED TO BE ATTENUATED AGAIN BY THIS CIRCUIT).



THIS DIAGRAM USES THE SYMBOL AT LOWER LEFT TO REPRESENT INPUT CIRCUIT GROUND (COMMON), AND THE SYMBOL AT LOWER RIGHT REPRESENTS A CONNECTION TO THE METAL CHASSIS WHICH IS IN TURN CONNECTED TO EARTH GROUND VIA THE POWER CORD.

THE IM-25 HAS ITS INPUT CIRCUIT GROUND, AND BY EXTENSION THE REGULATED DC POWER SUPPLY (B+ & B-), ISOLATED FROM THE MAIN CHASSIS AND EARTH GROUND. THE PROBE/TEST LEAD JACK IS MOUNTED ON A SPECIAL ALUMINUM SUB-PANEL, AS ARE THE VARIOUS CALIBRATION POTENTIOMETERS AND THE "ZERO SET" POTENTIOMETER; THE BUSHINGS OF THE SIX SELECTOR SWITCHES ALSO MOUNT TO THIS SAME SUB-PANEL. HOWEVER, EACH OF THE SWITCH BUSHINGS THEN PASS THROUGH A PAIR OF PLASTIC GROMMETS BEFORE FINALLY PASSING THROUGH THE PAINTED ALUMINUM FRONT PANEL, WHERE A FLAT WASHER AND AN ADDITIONAL 'CONTROL NUT' SECURE THE BUSHINGS. IT IS THE SWITCH BUSHINGS THAT HOLD THE SUB-PANEL TO THE MAIN CHASSIS, BUT THE PLASTIC GROMMETS ENSURE THAT NO ELECTRICAL CONNECTION IS MADE BETWEEN THE SUB-PANEL (AND ITS COMPONENTS) AND THE MAIN CHASSIS, AND THUS ALL METER CIRCUITRY IS ISOLATED FROM CHASSIS AND EARTH GROUND. AN AC-ONLY CONNECTION IS MADE VIA 0.005µF CAPACITOR 'C17' BETWEEN THE METER'S 'B-' POWER SUPPLY RAIL AND THE MAIN CHASSIS; FOR DC SIGNALS, THIS CAPACITOR'S REACTANCE IS PRACTICALLY INFINITE, AND AT AN AC SIGNAL OF 60Hz, THE REACTANCE IS ABOUT 530 kΩ.

NOTES:

1) ALL RESISTANCES ARE SHOWN IN OHMS UNLESS MARKED 'k' (KILO) OR 'M' (MEGA). ALL NON-POTENTIOMETER RESISTORS ARE WIREWOUND 'WW' TYPE UNLESS DENOTED 'CC' FOR CARBON COMPOSITION TYPE. ALL 'CC' RESISTORS ARE 1/2W AND 10% TOLERANCE UNLESS INDICATED. ALL 'WW' RESISTORS ARE 1% TOLERANCE AND, ALTHOUGH NOT MARKED, ARE PROBABLY 1W. POTENTIOMETERS ARE DENOTED ON HEATHKIT ASSEMBLY DIAGRAMS WITH 'TERMINAL 1' ON THE CCW END OF THE ELEMENT, 'TERMINAL 3' ON THE CW END OF THE ELEMENT, AND 'TERMINAL 2' ON THE WIPER, AND THESE TERMINAL NUMBERS ARE ALSO SHOWN ON THESE DRAWINGS; THE ACTUAL POTS ARE NOT SO MARKED.
2) ALL SWITCHES ARE SHOWN IN THEIR FULL COUNTER-CLOCKWISE POSITION.
3) WHERE SPARE SWITCH TERMINALS ARE USED AS TIE POINTS, THEIR HEATHKIT TERMINAL NUMBERS ARE SHOWN AND THEY ARE MARKED "TP" AND THE APPLICABLE SWITCH IDENTIFIER DESIGNATION IS GIVEN; IF NO "TP" OR DIFFERENT SWITCH IDENTIFIER DESIGNATION IS GIVEN, THE TERMINAL IS PART OF THE SAME ADJACENT SWITCH WAFER AND SIDE.
4) THE SIX SELECTOR SWITCHES ARE IDENTIFIED ON THESE DRAWINGS BY THE USE OF ABBREVIATED IDENTIFIERS, GIVEN AS A PREFIX, AND ON THE MORE COMPLEX SWITCHES A HYPHEN FOLLOWED BY A SUFFIX IS ADDED AFTER THE PREFIX. A PREFIX OF 'PS' REFERS TO "POWER SWITCH" (OFF/LINE/BATT), 'MS' IS FOR "MODE SWITCH" (AC/DC-/DC+), 'FS' IS FOR "FUNCTION SWITCH" (VOLTS/OHMS/MA) WHERE THESE DRAWINGS USE 'Ω' INSTEAD OF 'OHMS' AND 'mA' INSTEAD OF THE INCORRECT 'MA'. 'VRS' IS FOR "VOLTS" RANGE SWITCH, 'ORS' FOR "OHMS" RANGE SWITCH, AND 'ARS' FOR 'mA' RANGE SWITCH. THE SUFFIX, WHEN USED, REFERS TO THE SWITCH WAFER, e.g. '-W1' FOR "WAFER 1" AND '-W3' FOR "WAFER 3". SEE NOTE 10.
5) HOLES IN THE CIRCUIT BOARD WHERE WIRES TERMINATE ARE DESIGNATED BY SYLBOLS, WITH THE WIRE COLOR SHOWN ADJACENT TO THE SYMBOL. A SMALL SQUARE □ IS FOR CIRCUIT BOARD HOLES FOR COLORED WIRES TERMINATING IN THE REGION OF A LARGE GROUP OF ELECTRONIC COMPONENTS LOCATED NEAR THE POWER TRANSFORMER. A SIMILAR SQUARE SYMBOL WITH THE LETTER 'S' ADJACENT TO IT IS FOR ADDITIONAL (USUALLY WHITE IN COLOR) WIRES TERMINATING AT VARIOUS SINGLE PLACES AROUND THE CIRCUIT BOARD. A DIAMOND SHAPED SYMBOL ◇ IS FOR COLORED WIRES TERMINATING IN AN AREA OF THE CIRCUIT BOARD THAT IS LOCATED BETWEEN THE 'FUNCTION' SWITCH AND THE 'MODE' SWITCH.
6) SWITCH TERMINALS ARE DESIGNATED WITH A SMALL ROUND SYMBOL ◯; THE INTERNAL NUMBERS SHOWN ON THIS DRAWING MATCH THE ORIGINAL HEATHKIT SCHEMATICS. SIMILAR ROUND SYMBOLS WITH INTERNAL NUMBERS ARE USED FOR THE POTENTIOMETER TERMINALS.
7) THE ORIGINAL HEATHKIT COMBINATION TEST PROBE & SWITCH IS SHOWN ON THIS DRAWING. AS THESE ARE "UNOBTAINIUM" NOW, THEY MAY BE REPLACED USING SEPARATE "AC/OHMS" AND "DC" (WITH 1M SERIES RESISTOR) PROBES AND TEST LEADS. IN THE CASE OF THE IM-25, SUCH ALTERNATE PROBES REQUIRE THAT THE "AC/OHMS" PROBE OR PROBE SWITCH POSITION BE USED FOR MEASURING BOTH DC AND AC CURRENT (mA); THE "DC" PROBE IS USED ONLY FOR DC VOLTS.
8) SEE SHEET 3 OF THIS DRAWING FOR THEORY OF CIRCUIT OPERATION (AS IT APPLIES TO THE "OHMS" FUNCTION) AND DETAILS ON MAKING A BATTERY ELIMINATOR FOR USE IN PLACE OF THE OHMS FUNCTION 3V BATTERY AND MERCURY CELL.
9) MICA CAPACITORS C3, C5, C11, C12 ONLY NEED TO BE RATED AT 100V (MINIMUM) BUT HEATHKIT APPARENTLY SUPPLIED 300V RATED PARTS, AS SHOWN ON THIS SET OF SCHEMATICS.
10) MOST OF THE SELECTOR SWITCHES HAVE MULTIPLE WAFERS (DECKS), AND THE "mA" RANGE SWITCH 'ARS' HAS A WAFER WITH FRONT AND REAR HALVES. OFTEN THEIR PLATE & WIPER & CONTACT ARRANGEMENTS ARE COMPLEX, WHICH IN MOST CASES CANNOT BE CLEARLY DEPICTED USING COMPOSITE SYMBOLOGY. INSTEAD, THIS SCHEMATIC USES DIFFERENT STYLES OF SWITCH SYMBOLS, DEPENDING ON WHICH BEST SUITS THE SWITCH OPERATION. IN MOST CASES, THIS MATCHES HOW HEATHKIT SHOWS THEM IN THEIR SCHEMATIC DOCUMENTATION. DASHED LINES ARE NOT USED TO CONNECT BETWEEN DIFFERENT PARTS OF THE SAME SWITCHES; ONLY THE SWITCH DESIGNATIONS SHOW THEIR ASSOCIATION. SEE NOTE 4.
11) THIS FOUR SHEET SCHEMATIC INCLUDES MUCH ADDITIONAL INFORMATION NOT INCLUDED ON HEATHKIT'S DOCUMENTS. THIS ADDED INFORMATION WAS OBTAINED BY CAREFUL STUDY OF SEVERAL IM-25'S DURING THEIR RESTORATION. THIS ADDED INFORMATION IS INCLUDED WHENEVER ITS ABSENCE IN THE ORIGINAL DOCUMENTS PROVED TO BE PROBLEMATIC DURING THOSE RESTORATIONS.
12) THE IM-25 AS ORIGINALLY DESIGNED USED A TOTAL OF 14 "C" CELLS, PLUS A SPECIAL 1.35 MERCURY CELL, TO ALLOW 'CORDLESS' PORTABLE USE. SINCE THE LARGE UNWIELDY CASE DOES NOT LEND ITSELF TO PORTABLE APPLICATIONS, THE IM-25 IS MOST LIKELY ALWAYS USED AS A BENCH METER. HOWEVER, WHILE THE IM-25 ALREADY HAS AN INTERNAL AC LINE POWERED BATTERY ELIMINATOR TO REPLACE THE 18V BATTERY (COMPRISED OF 12x "C" CELLS), THE DESIGN DOES NOT ALLOW FOR SIMILAR AC LINE POWERED USE WHEN IN THE 'OHMS' FUNCTION; SINCE THE 3V BATTERY (2x "C" CELLS) AND THE 1.35V MERCURY CELL ARE NOT REPLACED BY DESIGNED-IN BATTERY ELIMINATORS. SEE NOTE 8 AND THE DIAGRAM ON SHEET 3 FOR DETAILS ON ADDING NEW BATTERY ELIMINATORS FOR THOSE 'OHMS' FUNCTION BATTERIES. IF BATTERY ELIMINATORS ARE USED TO REPLACE ALL BATTERIES, THE IM-25 WILL WORK WITH THE POWER SWITCH IN "LINE".

REVISION A 3-25-2023

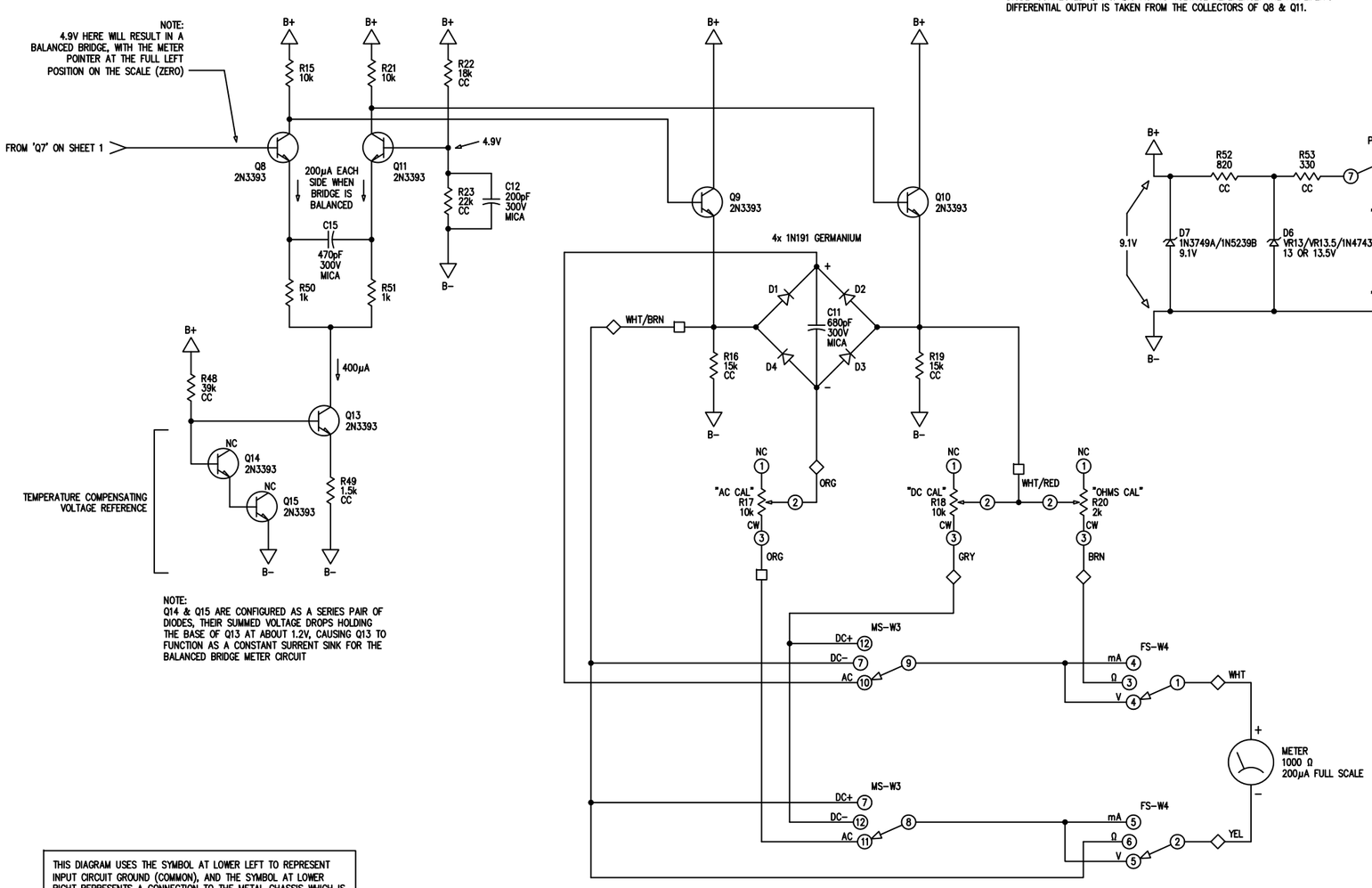
HEATHKIT IM-25 SOLID STATE VOM SCHEMATIC DIAGRAM

SHEET 2 OF 4

BALANCED BRIDGE METER CIRCUIT

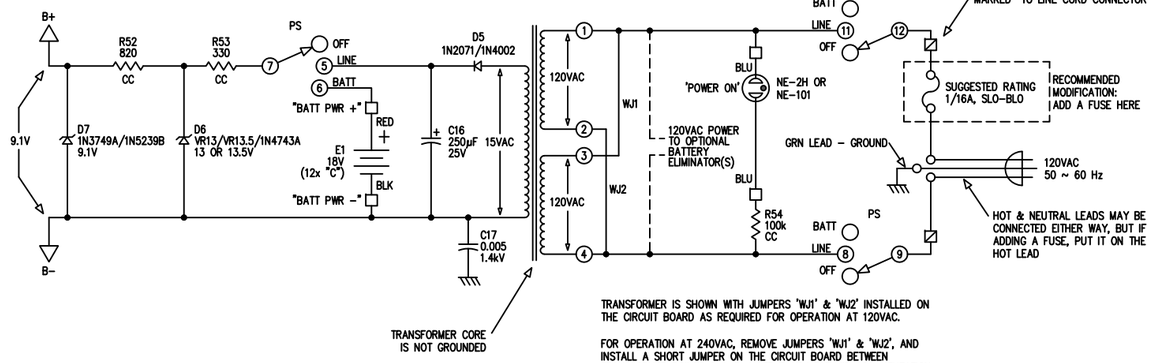
THE BALANCED BRIDGE CIRCUIT AT LOWER LEFT TAKES THE CONDITIONED SIGNAL FROM THE SOURCE (S) PIN OF HIGH IMPEDANCE AMPLIFIER Q7 (ON SHEET 1) AND COMPARES ITS VOLTAGE TO A FIXED REFERENCE VOLTAGE OF APPROXIMATELY 4.9V, WHICH IS PROVIDED BY A RESISTOR VOLTAGE DIVIDER COMPRISED OF RESISTORS R22 & R23 AND STABILIZED BY CAPACITOR C12. TRANSISTORS Q8 & Q11 FORM A DIFFERENTIAL AMPLIFIER, WITH THE Q7 SIGNAL ON THE BASE OF Q8 AND THE 4.9V REFERENCE ON THE BASE OF Q11. Q13 ACTS AS A CONSTANT CURRENT SINK FOR THE DIFFERENTIAL AMPLIFIER, USING DIODE-CONNECTED Q14 & Q15 AS ITS VOLTAGE REFERENCE. THE AMPLIFIER'S DIFFERENTIAL OUTPUT IS TAKEN FROM THE COLLECTORS OF Q8 & Q11.

THE ACTUAL BRIDGE CIRCUIT IS COMPRISED OF EMITTER-FOLLOWER TRANSISTORS Q9 & Q10 AND THEIR EMITTER RESISTORS R16 & R19. WHEN THE INPUT SIGNAL (FROM Q7) IS 4.9V, MATCHING THE 4.9V REFERENCE VOLTAGE, THE BRIDGE IS 'BALANCED' AND THE VOLTAGE DROPS ACROSS THE TWO EMITTER RESISTORS ARE EQUAL. VIA SOME SWITCHING AND OTHER COMPONENTS, THE ACTUAL METER MOVEMENT IS CONNECTED BETWEEN THE TOPS OF THE TWO EMITTER RESISTORS; IF BOTH RESISTORS HAVE THE SAME VOLTAGE ACROSS THEM, THERE IS NO CURRENT THROUGH THE METER AND ITS POINTER DOES NOT DEFLECT FROM THE FAR LEFT POSITION (IT READS ZERO). WHEN THE OUTPUT OF Q7 IS MORE POSITIVE, THE VOLTAGE ACROSS R19 IS GREATER THAN THAT ACROSS R16, AND CURRENT FLOWS THROUGH THE METER MOVEMENT FROM + TO −, RESULTING IN A POSITIVE POINTER DEFLECTION (THE POINTER MOVES UPSCALE). A LOWER Q7 VOLTAGE RESULTS IN THE OPPOSITE CURRENT FLOW THROUGH THE METER MOVEMENT, SO IT TRIES TO MOVE DOWNSCALE. KEEP IN MIND THAT SINCE 4.9V IS THE 'ZERO REFERENCE LEVEL' IN THE BRIDGE CIRCUIT, NEGATIVE DC SIGNALS OR THE NEGATIVE HALF OF AC SIGNALS BEING MEASURED WILL RESULT IN Q7 OUTPUT VOLTAGES OF LESS THAN 4.9V; THIS IS ACCOMMODATED BY THE SWITCHING WHICH REVERSES THE METER MOVEMENT POLARITY WHEN IN 'DC−' MODE, AND BY THE DIODE BRIDGE (D1~D4) WHEN IN THE 'AC' MODE. THREE SEPARATE TRIM POTENTIOMETERS (R17, R18, R20) ALLOW FINE TUNING (CALIBRATION) OF HOW MUCH EMITTER RESISTOR VOLTAGE DIFFERENCE RESULTS IN FULL SCALE METER DEFLECTION.



NOTE:
Q14 & Q15 ARE CONFIGURED AS A SERIES PAIR OF DIODES, THEIR SUMMED VOLTAGE DROPS HOLDING THE BASE OF Q13 AT ABOUT 1.2V, CAUSING Q13 TO FUNCTION AS A CONSTANT SURRENT SINK FOR THE BALANCED BRIDGE METER CIRCUIT

POWER SUPPLY

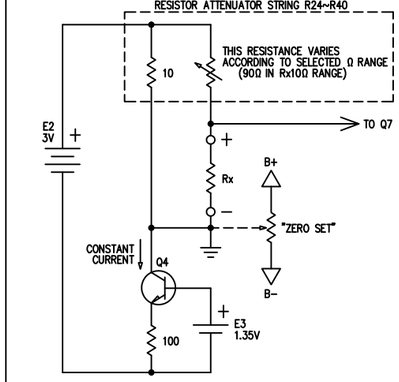


TRANSFORMER IS SHOWN WITH JUMPERS 'WJ1' & 'WJ2' INSTALLED ON THE CIRCUIT BOARD AS REQUIRED FOR OPERATION AT 120VAC.

FOR OPERATION AT 240VAC, REMOVE JUMPERS 'WJ1' & 'WJ2', AND INSTALL A SHORT JUMPER ON THE CIRCUIT BOARD BETWEEN TRANSFORMER POINTS 2 & 3; NOTE THAT HEATHKIT DOCUMENTATION DOES NOT MENTION THESE NUMBERS 1 ~ 4.

THE NEON BULB WIRING IS ALWAYS ACROSS THE SWITCHED LINE VOLTAGE REGARDLESS OF 120 OR 240 VOLT POWER.

OHMS FUNCTION SIMPLIFIED SCHEMATIC



THIS SIMPLIFIED DIAGRAM OMITS ALL OF THE SWITCHING AND REARRANGES THE COMPONENTS TO MAKE THE CIRCUIT FUNCTION CLEARER. SEE SHEET 1 FOR FULL CIRCUIT.

THE 3V BATTERY PROVIDES THE EXCITATION VOLTAGE THAT CAUSES CURRENT TO FLOW IN THE MAIN OHMS FUNCTION CIRCUIT LOOP. THE 1.35V CELL PROVIDES A REFERENCE VOLTAGE TO THE BASE OF Q4, WHICH ALONG WITH THE 100Ω RESISTOR FORMS A CONSTANT-CURRENT SINK, THEREBY REGULATING THE CURRENT IN THE MAIN OHMS FUNCTION CIRCUIT LOOP TO A CONSTANT AMOUNT.

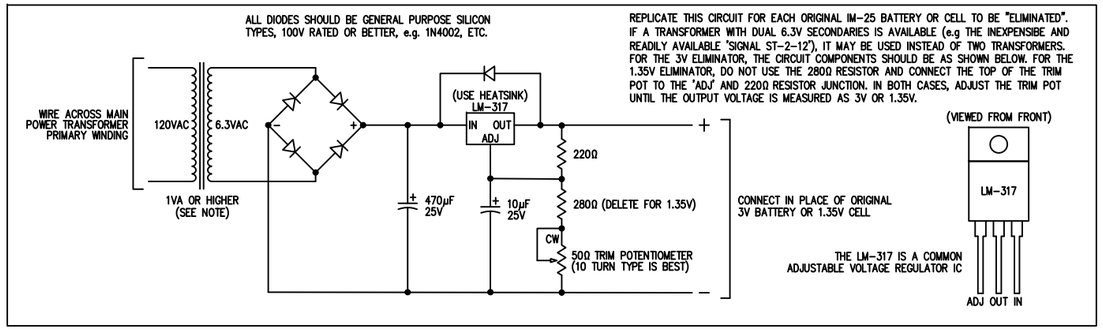
THE OTHER COMPONENT IN THE MAIN CIRCUIT LOOP IS A FIXED PRECISION 10Ω RESISTANCE, COMPRISED OF RESISTORS R24~R28 IN THE PRIMARY ATTENUATOR RESISTOR STRING. THE CONSTANT CURRENT IN THE LOOP CAUSES A CONSTANT VOLTAGE TO BE DEVELOPED ACROSS THAT 10Ω RESISTANCE.

A VOLTAGE DIVIDER, CONSISTING OF A RANGE-DEPENDENT PRECISION RESISTANCE (COMPRISED OF SOME OF THE RESISTORS IN THE PRIMARY ATTENUATOR RESISTOR STRING) AND THE SERIES CONNECTED RESISTANCE UNDER TEST (Rx) WHICH IS CONNECTED TO THE IM-25 VIA THE TEST LEADS/PROBE, PROVIDES A VOLTAGE TO HIGH IMPEDANCE AMPLIFIER Q7 THAT IS NON-LINEARLY RELATED TO THE RESISTANCE OF Rx. THE VOLTAGE PRESENTED TO Q7 CAN BE BIASED UP OR DOWN (FROM THE PERSPECTIVE OF THE BALANCED BRIDGE METER CIRCUIT) BY THE ACTION OF THE "ZERO SET" POTENTIOMETER AND ASSOCIATED "DC BIAS" POTENTIOMETERS (NOT SHOWN HERE). THIS ALLOWS 'ZEROING OUT' ANY ERRORS IN THE FRONT-END OHMS MEASUREMENT CIRCUIT AND TEST LEADS.

THIS DIAGRAM USES THE SYMBOL AT LOWER LEFT TO REPRESENT INPUT CIRCUIT GROUND (COMMON), AND THE SYMBOL AT LOWER RIGHT REPRESENTS A CONNECTION TO THE METAL CHASSIS WHICH IS IN TURN CONNECTED TO EARTH GROUND VIA THE POWER CORD.

THE IM-25 HAS ITS INPUT CIRCUIT GROUND, AND BY EXTENSION THE REGULATED DC POWER SUPPLY (B+ & B−), ISOLATED FROM THE MAIN CHASSIS AND EARTH GROUND. THE PROBE/TEST LEAD JACK IS MOUNTED ON A SPECIAL ALUMINUM SUB-PANEL, AS ARE THE VARIOUS CALIBRATION POTENTIOMETERS AND THE "ZERO SET" POTENTIOMETER; THE BUSHINGS OF THE SIX SELECTOR SWITCHES ALSO MOUNT TO THIS SAME SUB-PANEL. HOWEVER, EACH OF THE SWITCH BUSHINGS THEN PASS THROUGH A PAIR OF PLASTIC GROMMETS BEFORE FINALLY PASSING THROUGH THE PAINTED ALUMINUM FRONT PANEL, WHERE A FLAT WASHER AND AN ADDITIONAL 'CONTROL NUT' SECURE THE BUSHINGS. IT IS THE SWITCH BUSHINGS THAT HOLD THE SUB-PANEL TO THE MAIN CHASSIS, BUT THE PLASTIC GROMMETS ENSURE THAT NO ELECTRICAL CONNECTION IS MADE BETWEEN THE SUB-PANEL (AND ITS COMPONENTS) AND THE MAIN CHASSIS, AND THUS ALL METER CIRCUITRY IS ISOLATED FROM CHASSIS AND EARTH GROUND. AN AC-ONLY CONNECTION IS MADE VIA 0.005µF CAPACITOR 'C17' BETWEEN THE METER'S 'B−' POWER SUPPLY RAIL AND THE MAIN CHASSIS; FOR DC SIGNALS, THIS CAPACITOR'S REACTANCE IS PRACTICALLY INFINITE, AND AT AN AC SIGNAL OF 60Hz, THE REACTANCE IS ABOUT 530 kΩ.

SUGGESTED 'OHMS FUNCTION' BATTERY ELIMINATOR SCHEMATIC
(TWO OF THESE REQUIRED)



NOTES AND OTHER INFORMATION ARE LOCATED ON SHEET 2 OF THIS DRAWING

HEATHKIT IM-25 SOLID STATE VOM SCHEMATIC DIAGRAM

SHEET 3 OF 4

REVISION A 3-25-2023

CALIBRATION

DC CALIBRATION:

1) TURN ALL FRONT PANEL SWITCHES AND THE FIVE TRIM POTENTIOMETERS (TRIM POTS) TO THEIR FULLY COUNTER-CLOCKWISE POSITIONS. THE 'FUNCTION' SWITCH (LABELED 'VOLTS/OHMS/MA') WILL BE IN THE 'VOLTS' POSITION.
2) NOTE THAT THE 'DC BIAS' AND 'DC CAL' TRIM POTS ARE LOCATED ON THE SUB-PANEL, JUST ABOVE THE TOP ROW OF FRONT PANEL SWITCH KNOBS AND ACCESSIBLE WITH THE IM-25'S TOP COVER REMOVED.
3) SET THE 'MODE' SWITCH TO 'DC+'.
4) TURN THE 'ZERO SET' THUMBWHEEL (LABELED 'ZERO' WITH UP AND DOWN ARROWS) TO ITS 'FULL UP' POSITION. THIS CAN BE FELT WHEN MORE EFFORT IS REQUIRED TO TURN THE THUMBWHEEL AND/OR WHEN THE BALL BEARINGS ON THE REAR OF THE TRIM POT STOP TURNING.
5) ADJUST THE ZERO SET SCREW ON THE LOWER FRONT OF THE METER MOVEMENT UNTIL THE POINTER READS ZERO (LIGHTLY TAP THE METER FACE WHILE MAKING THE ADJUSTMENT).
6) MAKE SURE THAT THE TEST LEADS' PLUG IS UNPLUGGED FROM THE FRONT PANEL JACK.
7) PLUG THE IM-25 POWER CORD INTO AN AVAILABLE AC OUTLET, AND TURN THE 'POWER SWITCH' (LABELED 'OFF/LINE/BATT) TO THE 'LINE' POSITION. THE METER POINTER WILL PROBABLY DEFLECT FULLY UPSCALE (TO THE RIGHT).
8) VERY SLOWLY TURN THE 'DC BIAS' TRIM POT CLOCKWISE UNTIL THE METER POINTER MOVES LEFT AND TO THE ZERO POSITION ON ITS SCALE. THE ADJUSTMENT IS VERY TOUCHY; THIS IS NORMAL AND NOT IMPORTANT, SINCE THE IDEA IS TO JUST GET AS CLOSE TO ZERO AS POSSIBLE.
9) IDENTIFY A SUITABLE REGULATED DC POWER SOURCE, SUCH AS A BENCH POWER SUPPLY. SET IT TO 10V AND VERIFY WITH THE SUPPLY'S OWN METER OR A SEPARATE DC VOLTMETER; THE ACTUAL VOLTAGE IS NOT IMPORTANT, AS LONG AS IT IS LESS THAN 15V AND ITS EXACT VALUE IS VERIFIED.
10) TURN THE 'VOLTS RANGE' SWITCH TO ITS '15V' POSITION.
11) PLUG THE TEST LEADS INTO THE JACK ON THE LOWER RIGHT OF THE IM-25'S FRONT PANEL, AND CONNECT THE BLACK (-) TEST LEAD TO THE (-) SIDE OF THE POWER SUPPLY, AND THE 'DC' (+) PROBE TO THE (+) SIDE OF THE POWER SUPPLY.
12) ADJUST THE 'DC CAL' TRIM POT UNTIL THE METER INDICATES 10 (OR WHATEVER THE SELECTED POWER SUPPLY VOLTAGE IS) ON THE 15V DC SCALE.
13) DISCONNECT THE TEST LEADS FROM THE POWER SUPPLY AND CLIP THE BLACK TEST LEAD TO THE 'DC' (+) PROBE, SO THAT THE IM-25'S INPUT IS SHORTED.
14) VERY SLOWLY TURN THE 'DC BIAS' CLOCKWISE UNTIL THE METER INDICATES BETWEEN 40 AND 45 ON THE 50V DC SCALE.
15) TURN THE 'ZERO SET' THUMBWHEEL DOWNWARDS UNTIL THE METER READS ZERO.
16) TURN THE MODE SWITCH TO 'DC-' AND CONTINUE TO TURN THE 'ZERO SET' THUMBWHEEL DOWNWARDS UNTIL IT REACHES ITS FULLY DOWN POSITION (MORE EFFORT TO TURN IT AND/OR THE BALL BEARINGS STOP TURNING); THE METER SHOULD NOW INDICATE UPSCALE TO APPROXIMATELY 15 TO 20 ON THE 50V DC SCALE.
17) TURN THE 'ZERO SET' THUMBWHEEL UPWARDS AGAIN, ADJUSTING UNTIL THE METER INDICATES ZERO.
18) SWITCH THE 'MODE' SWITCH BACK AND FORTH BETWEEN 'DC-' AND 'DC+' POSITIONS; THE METER POINTER SHOULD REMAIN AT ZERO, OR JUST VERY SLIGHTLY OFF OF ZERO. NOTE THAT WHEN MOVING THE SWITCH, THERE MIGHT BE A SLIGHT METER POINTER FLUNCTUATION, BUT THE POINTER SHOULD RETURN TO ZERO.
19) REPEAT STEPS 10 THROUGH 12 TO VERIFY THAT THE METER STILL INDICATES 10V ON THE 15V DC SCALE (OR WHATEVER POWER SUPPLY VOLTAGE YOU USED); ADJUST THE 'DC CAL' IF NEEDED.
20) DC VOLTS AND DC mA ARE NOW CALIBRATED (THERE IS NO CALIBRATION TRIM POT FOR DC mA CURRENT).

AC CALIBRATION:

1) THIS PROCEDURE ASSUMES THAT AN AUDIO SQUARE WAVE GENERATOR AND OSCILLOSCOPE CALLED FOR IN HEATHKIT'S MANUAL ARE NOT AVAILABLE. IF BOTH ARE AVAILABLE, REFER TO THE ACTUAL HEATHKIT IM-25 MANUAL'S AC CALIBRATION PROCEDURE STARTING ON PAGE 33 FOR THE FULL PROCEDURE. HOWEVER, THE FOLLOWING PROCEDURE WORKS WELL IF THE IM-25 IS GOING TO BE USED PRIMARILY FOR LOWER FREQUENCY AC VOLTAGE MEASUREMENTS.
2) A SEPARATE HIGH INPUT IMPEDANCE DC VOLTMETER IS REQUIRED FOR THE PROCEDURE BELOW. ANY MODERN SOLID STATE MULTIMETER WILL WORK FOR THIS PURPOSE.
2) NOTE THAT THE 'AC BIAS' AND 'AC CAL' TRIM POTS ARE LOCATED ON THE SUB-PANEL, JUST ABOVE THE TOP ROW OF FRONT PANEL SWITCH KNOBS AND ACCESSIBLE WITH THE IM-25'S TOP COVER REMOVED.
3) ON THE SUB-PANEL, ADJUST TRIM CAPACITORS 'C2 & 'C4' BY TURNING THEIR SCREWDRIVER ADJUSTMENT SLOTS SO THAT THE SLOTS ARE PERPENDICULAR (AT RIGHT ANGLES) TO THE IM-25'S FRONT PANEL. THIS SHOULD LEAVE THESE CAPACITORS SET TO ROUGHLY THEIR CENTER OF ROTATION.
4) MAKE SURE THAT THE 'FUNCTION' SWITCH TO ITS 'VOLTS' POSITION.
5) TURN THE 'VOLTS RANGE' SWITCH TO ITS 5V POSITION.
6) LOCATE THE 47k CARBON COMPOSITE RESISTOR 'R8', WHICH IS ON THE REAR SIDE OF WAFER 2 OF THE 'VOLTS RANGE' SWITCH; THIS WAFER HAS A LOT OF DISCRETE COMPONENTS WIRED TO IT, AND THIS RESISTOR IS THE ONLY CARBON COMPOSITE (NON-WIREWOUND) TYPE MOUNTED ON ANY OF THE SWITCHES, AND IT IS MARKED WITH YELLOW-VIOLET-ORANGE-GOLD COLOR BANDS.
7) CONNECT THE SEPARATE DC VOLTMETER'S TEST LEADS ACROSS THE 47k RESISTOR 'R8'.
8) ADJUST THE 'AC BIAS' TRIM POT UNTIL THE SEPARATE DC VOLTMETER INDICATES EXACTLY 6V. NOTE THAT THERE WILL BE SOME LAG IN THE METER READING AS THE ADJUSTMENT IS MADE, SO IT IS BEST TO MAKE A SMALL ADJUSTMENT, WAIT UNTIL THE METER READING STABILIZES, THEN ADJUST AGAIN IF NECESSARY.
9) DISCONNECT THE SEPARATE DC VOLTMETER FROM RESISTOR R8.
10) CHOOSE A FAIRLY STABLE AC VOLTAGE TO USE AS A REFERENCE; IT IS PROBABLY EASIEST TO USE THE 120V LINE VOLTAGE. SINCE THE IM-25 MEASUREMENT CIRCUITRY IS ISOLATED FROM THE INCOMING AC POWER, IT IS SAFE TO USE THE SAME AC POWER SOURCE FOR THE FOLLOWING STEPS.
11) USING A SEPARATE AC VOLTMETER (THIS WILL PROBABLY BE THE SAME MULTIMETER USED FOR SETTING THE 'AC BIAS' TRIM POT), NOTE THE ACTUAL VOLTAGE OF THE AC REFERENCE VOLTAGE, e.g. ABOUT 120V.
12) SET THE 'VOLTS RANGE' SWITCH TO ITS 150V POSITION, AND CONNECT THE IM-25'S TEST LEADS TO THE AC REFERENCE VOLTAGE.
13) ADJUST THE 'AC CAL' TRIM POT UNTIL THE IM-25'S METER MOVEMENT INDICATES THE AC REFERENCE VOLTAGE AS READ ON THE 150V SCALE (MAKE SURE TO READ FROM THE RED 'RMS AC' SCALE WHICH ENDS WITH '15' AT ITS RIGHT SIDE; 15 ON THIS SCALE MEANS 150VAC).
14) DISCONNECT THE IM-25'S TEST LEADS FROM THE AC REFERENCE VOLTAGE.
15) AC VOLTS IS NOW CALIBRATED. THERE IS NO SEPARATE CALIBRATION FOR AC mA.

INFORMATIVE VIDEO:

THE AUTHOR OF THIS SET OF DRAWINGS HAS PRODUCED A YOUTUBE VIDEO, DETAILING MANY THINGS ABOUT THE IM-25 THAT WERE LEARNED OVER THE COURSE OF RESTORING SEVERAL OF THESE METERS.

THE VIDEO IS TITLED "HEATHKIT IM-25 (ALSO IM-16): THINGS I HAVE LEARNED ABOUT RESTORING THESE TO OPERATION", AND THE DIRECT URL IS: https://youtu.be/NAHTYEGeccl

OHMS CALIBRATION:

1) ESPECIALLY WHEN MEASURING OR CALIBRATING THE OHMS FUNCTION, ALWAYS CHECK THE METER FOR A ZERO READING BEFORE TAKING A RESISTANCE READING OR PERFORMING A CALIBRATION STEP. THE ZEROING IN THE OHMS FUNCTION IS NOT VERY STABILE, AND WILL LIKELY CHANGE (AND REQUIRE ADJUSTMENT) ANY TIME THE 'OHMS RANGE' SWITCH POSITION IS CHANGED. TO ZERO THE METER FOR THE OHMS FUNCTION, TURN THE 'FUNCTION' SWITCH TO 'VOLTS', AND THE 'MODE' SWITCH SET ALTERNATELY TO 'DC-' AND 'DC+', ADJUSTING THE 'ZERO SET' THUMBWHEEL SO THAT THE METER POINTER REMAINS AT ZERO FOR BOTH POSITIONS OF THE SWITCH. AFTER PERFORMING THIS INITIAL ZEROING, WHILE MAKING RESISTANCE READINGS YOU SHOULD OFTEN SHORT THE TEST PROBE (THE AC/OHMS PROBE) TO THE BLACK TEST LEAD, AND RE-ADJUST THE 'ZERO SET' THUMBWHEEL AS REQUIRED TO OBTAIN A ZERO READING.
2) FOR MAKING RESISTANCE MEASUREMENTS, ALWAYS MAKE SURE TO USE THE TEST PROBE MARKED 'AC/OHMS', OR A COMBINATION PROBE WITH ITS SWITCH SET TO AC/OHMS. ACCIDENTALLY USING THE 'DC' TEST PROBE WILL SKEW ALL RESISTANCE READINGS BY 1M OHM !
3) SET THE 'FUNCTION' SWITCH TO ITS 'OHMS' POSITION.
4) SET THE 'OHMS RANGE' SWITCH TO THE 'Rx1' POSITION.
5) SHORT THE TEST PROBE TO THE BLACK TEST LEAD AND VERIFY THAT THE METER GIVES A READING OF ZERO; IF NOT, ADJUST THE 'ZERO SET' THUMBWHEEL.
6) UN-SHORT THE TEST PROBE FROM THE BLACK TEST LEAD, AND ADJUST THE 'OHMS CAL' TRIM POT UNTIL THE METER POINTER RESTS DIRECTLY OVER THE LAST SCALE MARK AT THE FAR RIGHT END OF THE GREEN OHMS SCALE.
7) RE-SHORT THE TEST PROBE TO THE BLACK TEST LEAD AND VERIFY THAT THE METER POINTER FALLS BACK TO ZERO OR NEARLY SO (DUE TO THE INHERENT RESISTANCE OF THE TEST LEADS, THE METER WILL LIKELY READ SOME SMALL RESISTANCE OF 1Ω OR LESS.....LESS THAN 0.2Ω, OR POINTER BELOW THE FIRST GREEN SCALE MARK AT THE RIGHT OF ZERO, IS IDEAL).
8) TURN THE 'OHMS RANGE' SWITCH THROUGH ALL OF ITS POSITIONS; THE METER POINTER SHOULD REMAIN AT ESSENTIALLY THE ZERO POINT FOR ALL RANGES ABOVE 'Rx1'.
9) IN THE FOLLOWING STEPS, THE 1M RESISTOR THAT IS BUILT INTO THE 'DC' TEST PROBE WILL BE USED TO CHECK THE HIGHEST OHMS RANGES.
10) TURN THE 'OHMS RANGE' SWITCH TO THE 'Rx1M" POSITION.
11) USE THE 'DC' TEST PROBE, OR SET THE COMBINATION TEST PROBE'S SWITCH TO THE 'DC' POSITION, AND MAKE SURE THAT THE PROBE IS SHORTED TO THE BLACK TEST LEAD. THE METER POINTER SHOULD FALL TO THE LEFT THE '1' MARK ON THE GREEN OHMS SCALE.
12) TURN THE 'OHMS RANGE' SWITCH TO ITS 'Rx100K' POSITION, AND VERIFY THAT THE METER POINTER FALLS OVER THE '10' MARK ON THE GREEN SCALE (10 x 100k = 1M).
13) TURN THE 'OHMS RANGE' SWITCH TO ITS 'Rx10k' POSITION, AND VERIFY THAT THE METER POINTER FALLS OVER THE '100' MARK ON THE GREEN SCALE (100 x 10k = 1M).
14) IF MORE THAN A SLIGHT ERROR IS NOTED IN THE METER READINGS OBTAINED IN STEPS 11~13, SLIGHTLY TWEAK THE 'OHMS CAL' TRIM POT FOR A COMPROMISE READING BETWEEN THE THREE SWITCH POSITIONS. DO NOT CHANGE THE 'ZERO SET' THUMBWHEEL POSITION WHILE MAKING THE ABOVE TESTS.
15) DISCONNECT THE 'DC' TEST PROBE FROM THE BLACK TEST LEAD.
16) THE OHMS FUNCTION IS NOW CALIBRATED.

SPECIFICATIONS

DC VOLTS:
- NINE RANGES 0.15V, 0.5V, 1.5V, 5V, 15V, 50V, 150V, 500V, 1500V FULL SCALE
- INPUT IMPEDANCE = 11M ON ALL RANGES
- ACCURACY = +/- 3% OF FULL SCALE

DC CURRENT:
- ELEVEN RANGES 0.015mA, 0.05mA, 0.15mA, 0.5mA, 5mA, 15mA, 50mA, 150mA, 500mA, 1500mA (1.5A)
- INSERTION RESISTANCE = VARIES FROM 10kΩ (IN THE 0.15mA RANGE) TO 0.1Ω (IN THE 1500mA RANGE)
- ACCURACY = +/- 4% OF FULL SCALE

AC VOLTS:
- NINE RANGES 0.15V, 0.5V, 1.5V, 5V, 15V, 50V, 150V, 500V, 1500V FULL SCALE
- INPUT IMPEDANCE = 10M ON ALL RANGES, SHUNTED BY 175pF (MEASURED AT THE 'AC/OHMS' PROBE TIP)
- ACCURACY = +/- 5% OF FULL SCALE
- FREQUENCY RESPONSE = +/- 2dB, 10Hz~100kHz

AC CURRENT:
- ELEVEN RANGES 0.015mA, 0.05mA, 0.15mA, 0.5mA, 5mA, 15mA, 50mA, 150mA, 500mA, 1500mA (1.5A)
- INSERTION RESISTANCE = VARIES FROM 10kΩ (AT 0.15mA RANGE) TO 0.1Ω (AT 1500mA RANGE)
- ACCURACY = +/- 5% OF FULL SCALE

OHMS:
- SEVEN RANGES: Rx1 (10Ω AT CENTER OF OHMS SCALE), Rx10, Rx100, Rx1k, Rx10k, Rx100k, Rx1M
- ACCURACY = NOT SPECIFIED BY HEATHKIT

POWER SUPPLIES:
- AMPLIFIER/METER MOVEMENT CIRCUIT: 18V, FROM EITHER BATTERY 'E1' (COMPRISED OF 12x "C" CELLS) OR FROM THE AC POWER LINE (120VAC OR 240VAC) VIA THE BUILT-IN POWER SUPPLY
- OHMS EXCITATION: 3V, FROM BATTERY 'E2' (COMPRISED OF 2x "C" CELLS)
- OHMS CONSTANT CURRENT REGULATOR: 1.35V MERCURY CELL 'E3' (NEDA 1100) [NOW OBSOLETE AND "UNOBTAINIUM"......NOTE THAT MODERN 'SUBSTITUTE' ALKALINE CELLS OF THIS SAME SIZE AND SHAPE WILL NOT WORK IN THIS CIRCUIT]
- FOR ANY IM-25 THAT IS EXPECTED TO BE ACTUALLY USED, IT IS RECOMMENDED TO DISPENSE WITH ALL BATTERY POWER INSIDE THE METER, AND CONVERT THE IM-25 TO 'AC POWER ONLY' BY INSTALLATION OF BATTERY ELIMINATORS FOR 'E2' & 'E3' (SEE DETAILS ELSEWHERE ON THIS SET OF DRAWINGS). THIS ALSO AVOIDS ALL ISSUES RELATED TO BATTERY LEAKAGE.

SEMICONDUCTORS:
- 2x 2N4304 FET TRANSISTORS
- 13x 2N3393 GENERAL PURPOSE NPN SILICON BJT TRANSISTORS
- 1x GENERAL PURPOSE SILICON DIODE 1A, 100PIV OR HIGHER (1N2071 OR 2N4000 SERIES e.g. 1N4002 OR HIGHER)
- 1x 9.1V ZENER DIODE (1N3749A OR 1N5239A)
- 1x 13V OR 13.5V ZENER DIODE (VR14 OR VR13.5 OR 1N4743A)
- 4x 1N191 'CRYSTAL DIODE' (GERMANIUM TYPE) [SILICON DIODES WILL NOT WORK FOR THIS PURPOSE]

GENERAL:
- CIRCUIT GROUND ISOLATED FROM METER CHASSIS AND EARTH GROUND (VIA THE AC POWER CORD)
- TEST PROBE IS EITHER A TYPICAL "VTVM" TEST LEAD SET, OR THE ORIGINAL COMBINATION TEST PROBE WITH DC/AC-OHMS SWITCH, OR MODERN REPLACEMENTS USING SEPARATE TEST PROBES FOR 'DC VOLTAGE ONLY' AND 'AC/OHMS' (FOR AC VOLTS, ALL CURRENT, AND OHMS); THE 'DC ONLY' PROBE MUST HAVE AN INTEGRAL PRECISION 1M RESISTOR CONNECTED BETWEEN THE END OF THE (+) TEST LEAD AND THE PROBE TIP
- MAIN ATTENUATOR AND AC ATTENUATOR VOLTAGE DIVIDERS ARE COMPRISED OF 1% TOLERANCE PRECISION WIREWOUND RESISTORS
- METER MOVEMENT IS 6", 200μA FULL SCALE, 1000Ω RESISTANCE, 100 DEGREE MOVEMENT
- DIMENSIONS: 13-1/2" WIDE, 5-1/8" HIGH, 6-1/4" DEEP
- NET WEIGHT: 9 POUNDS WITH BATTERIES INSTALLED

OPERATION

WHICH PROBE TO USE:
- THE IM-25 CAN USE SEVERAL VARIATONS OF TEST PROBE. IT COMES WITH THE SPECIAL HEATHKIT "VTVM" STYLE COMBINATION PROBE, WHICH HAS A SWITCH FOR SELECTING 'DC' VOLTS ONLY, OR 'AC/OHMS' WHICH IS GOOD FOR MEASURING EVERYTHING EXCEPT DC VOLTS, i.e IT SHOULD BE USED FOR AC VOLTS, DC & AC CURRENT (mA), AND OHMS. SINCE THE ORIGINAL PROBE IS USUALLY LOST OR BROKEN, AND CANNOT BE DIRECTLY REPLACED, ONE OF THE FOLLOWING VARIATIONS MAY BE USED.
- MODERN REPRODUCTION "VTVM" PROBES, WHICH HAVE A SINGLE TEST LEAD PLUG WITH THREE TEST LEADS COMING FROM IT, ONE LEAD WITH AN ALLIGATOR CLIP (COMMON), ONE LEAD WITH RED PROBE FOR 'DC' VOLTS ONLY, AND THE THIRD LEAD WITH BLACK PROBE FOR 'AC/OHMS' AND ALSO DC & AC CURRENT.
- SEPARATE PROBE SETS, ONE SET FOR 'DC' VOLTS ONLY AND THE OTHER SET FOR 'AC/OHMS' AND ALSO FOR DC & AC CURRENT. THIS IS ELECTRICALLY THE SAME AS THE REPRODUCTION "VTVM" PROBES, EXCEPT EACH PROBE SET HAS ITS OWN DEDICATED TEST LEAD PLUG, REQUIRING THE PLUGS TO BE SWAPPED BACK AND FORTH IF FREQUENTLY MEASURING DIFFERENT KINDS OF SIGNALS.
- IN ALL OF THE ABOVE, ONLY THE 'DC' PROBE WILL HAVE AN INTEGRAL PRECISION 1MΩ RESISTOR CONNECTED BETWEEN THE END OF THE TEST LEAD AND THE TIP OF THE PROBE. THE PROBE(S) FOR EVERY KIND OF SIGNAL EXCEPT 'DC' VOLTS DOES NOT HAVE THE INTEGRAL RESISTOR, AND THE END OF THE ASSOCIATED TEST LEAD CONNECTS DIRECTLY TO THE PROBE TIP.
- IF USING A NORMAL "VTVM" TYPE PROBE SET, WHERE A SINGLE SHARED PLUG IS USED, BE AWARE THAT THE CURRENTLY UNUSED PROBE WILL STILL BE ENERGIZED (VIA THE TEST LEADS) COMING FROM THE PROBE BEING USED. WHILE THE SAME VOLTAGE WILL BE PRESENT, THERE WILL BE THE INTEGRAL 1MΩ RESISTANCE BETWEEN THE TWO PROBES, WHICH AT LEAST LIMITS THE CURRENT SOMEWHAT. YET ESPECIALLY WHEN MEASURING HIGHER VOLTAGES USING THESE PROBES, IT IS BEST PRACTICE TO SOMEHOW INSULATE THE PROBE THAT IS NOT CURRENTLY IN USE, AND PREFERABLY HAVE SOME PLACE TO STOW IT AWAY FROM CONTACT WITH YOUR BODY OR CONDUCTIVE SURFACES.

METER ISOLATION:
- THE METER'S INTERNAL CIRCUITRY IS ELECTRICALLY ISOLATED FROM THE METER CHASSIS (EXCEPT FOR THE INTERNAL SUB-PANEL) AND FROM EARTH GROUND VIA THE AC POWER CORD. THIS ALLOWS DIRECT MEASUREMENTS TO BE MADE ON AC POWERED EQUIPMENT WITHOUT WORRYING ABOUT ELECTRICAL ISOLATION. THE IM-25 CHASSIS AND CABINET WILL NOT ACCIDENTALLY BECOME CONNECTED TO AC VOLTAGE DURING MEASUREMENTS OF EQUIPMENT. OF COURSE, THE IM-25 WAS BUILT FROM A KIT, AND A CAVEAT MUST BE GIVEN BECAUSE OF THE POSSIBILITY THAT THE METER WAS NOT ASSEMBLED CORRECTLY BY THE KIT BUILDER, OR SUBSEQUENT MODIFICATIONS MIGHT HAVE BEEN MADE THAT WOULD ELECTRICALLY BOND THE METER CHASSIS/CASE TO EARTH GROUND OR OTHER ELECTRICAL POTENTIALS.

READING THE METER:
- THE VOLTAGE MARKINGS ON THE 'VOLTS RANGE' SWITCH REFER TO THE FULL-SCALE READINGS ON THE METER MOVEMENT. THERE ARE TWO DC SCALES PRINTED IN BLACK, READING UP TO 15 & 50, AND THESE SCALES PERTAIN TO BOTH DC VOLTS AND DC CURRENT MEASUREMENTS. THERE ARE ALSO TWO AC SCALES PRINTED IN RED, READING UP TO 15 & 50, AND THESE PERTAIN TO BOTH AC VOLTS AND AC CURRENT MEASURMENTS. THERE ARE ALSO TWO MORE DC SCALES WHICH ARE MARKED WITH ZERO AT THE CENTER, ALLOWING MEASUREMENT OF SIGNALS WHICH MIGHT SOMETIMES BE POSITIVE AND SOMETIMES BE NEGATIVE AND YET THEY CAN BE MEASURED WITHOUT SWITCHING THE 'MODE' BACK AND FORTH BETWEEN 'DC-' & 'DC+'; THE 'ZERO SET' THUMBWHEEL IS USED TO MOVE THE NORMAL ZERO POSITION FROM THE FAR LEFT SIDE OF THE SCALE TO THE SPECIAL ZERO-CENTER POSITION. ALWAYS USE THE RED SCALES WHEN MEASURING AC SIGNALS, AS THE SCALING HAS BEEN MODIFIED TO GIVE THE CORRECT READINGS WHEN THE METER CIRCUIT NEEDS TO SEND THE SIGNAL THROUGH THE DIODE BRIDGE WITH ITS INHERENT VOLTAGE DROP.
- FOR MEASURING RESISTANCE (OHMS), USE THE TOP SCALE PRINTED IN GREEN.
- TO READ VALUES ON ANY VOLTS OR CURRENT RANGE WITH (BESIDES '0') ONLY A '5' IN IT, USE THE SCALE WITH A '50' AT THE RIGHT SIDE OF THE METER FACE, e.g. IF ON THE 0.5V RANGE, USE THE SCALE ENDING WITH 50, AND IF ON THE 0.15V RANGE, USE THE SCALE ENDING WITH 15. IF ON THE 150mA CURRENT RANGE, USE THE SCALE ENDING WITH 15, AND IF ON THE 0.05mA CURRENT RANGE, USE THE SCALE ENDING WITH 50. AGAIN, MAKE SURE TO USE THE APPROPRIATE 'DC' (BLACK) AND 'AC' (RED) SCALES, MATCHING THE SIGNAL TYPE.
- TO READ VALUES IN OHMS, READ THE NUMBER ON THE GREEN SCALE AND THEN MULTIPLY THAT NUMBER BY THE RANGE MULTIPLIER , e.g. IF IN THE 'Rx1' RANGE, THE SCALE IS READ DIRECTLY IN OHMS, AND IF IN THE Rx100 RANGE, READ THE NUMBER FROM THE METER SCALE AND MULTIPLY BY 100 TO GET THE ACTUAL OHMS VALUE.

DC VOLTAGE MEASUREMENTS:
- SET THE 'MODE' SWITCH TO EITHER 'DC-' OR 'DC+' POSITION. THESE TWO OPTIONS ALLOW READING UPSCALE ON THE METER EVEN IF THE PROBES ARE CONNECTED TO A POSITIVE VOLTAGE BUT WITH THE POLARITY OF THE PROBES SWAPPED, OR DELIBERATELY MEASURING A SIGNAL WHOSE POLARITY IS INITIALLY UNKNOWN, WITHOUT THE NEED TO CHANGE PROBE CONNECTIONS OF INCORRECTLY GUESSING THE POLARITY.
- BECAUSE OF THE HIGH INPUT IMPEDANCE OF THE METER WHILE IN THE 'DC VOLTS' FUNCTION, THE METER IS ABLE TO MEASURE VOLTAGES WITHOUT SIGNIFICANTLY LOADING THE CIRCUIT BEING TESTED. THIS CHARACTERISTIC ENABLES THE VOLTAGE TO BE MEASURED ACCURATELY SINCE IT IS UNLIKELY TO 'SAG' DUE TO THE LOADING PRESENTED BY THE METER.
- IF THE APPROXIMATE VOLTAGE TO BE TESTED IS UNKNOWN, SET THE 'VOLTS RANGE' SWITCH TO A HIGHER POSITION, AND THEN SWITCH TO A LOWER POSITION IF THE INITIAL READING SHOWS THAT THE RANGE IS TOO HIGH.

AC VOLTAGE MEASUREMENTS:
- SET THE 'MODE' SWITCH TO THE 'AC' POSITION. CAVEAT; IF AN AC SIGNAL HAS A VERY LOW FREQUENCY, e.g. LOWER THAN 0.5Hz, AND IT IS DESIRED TO SEE THE SWING RATHER THAN ACTUALLY READ THE VOLTAGE, THE 'MODE' SWITCH CAN BE SELECTED TO EITHER OF THE 'DC' POSITIONS (USE THE 'DC' PROBE), AND THE SLOWLY CHANGING AC SIGNAL CAN BE READ AS A VARYING DC SIGNAL (FOR THIS, FIRST USE THE 'ZERO SET' THUMBWHEEL TO CENTER THE METER ON THE SPECIAL DC SCALE WITH THE ZERO POSITION AT SCALE CENTER). NOTE THAT THE IM-25 IS RATED FOR FOR NO LESS THAN 10Hz WHILE TAKING AC MEASUREMENTS; TRYING TO MEASURE AC SIGNALS BELOW 10Hz YET ABOVE 0.5Hz WILL LIKELY RESULT IN JERKY METER MOVEMENT AND INACCURATE READINGS.
- THE MAXIMUM AC VOLTAGE THAT CAN BE SAFELY MEASURED WITH THE IM-25 IS 1500V AND THIS LIMIT MUST NOT BE EXCEEDED, AS THE INTERNAL PROTECTION IS LIMITED IN CAPABILITY, AND BOTH THE PROTECTION COMPONENTS AND THE REST OF THE METER CIRCUITRY ARE LIKELY TO BE DAMAGED.
- THE METER IS CALIBRATED TO READ THE ROOT-MEAN-SQUARE (RMS) VALUE OF A PURE SINE WAVE, AND THIS IS 70.7% OF THE MEASURED SIGNAL'S PEAK VOLTAGE. WHEN MEASURING ODD-SHAPED (NON-SINUSOIDAL) WAVEFORMS, e.g. SQUARE WAVES, SAWTOOTH OR TRIANGLE WAVES, PULSE WAVES, THE METER READING MUST BE GIVEN SPECIAL INTERPRETATION TO THE 'AVERAGE' VALUE FROM THE WAVEFORM. KEEP IN MIND THAT THE METER WILL BE READING AVERAGE VALUES THAT PROBABLY WILL NOT INDICATE THE HIGHEST POINTS ON THE ODD-SHAPED WAVEFORMS, AND SOMETIMES THE DISPARITY CAN BE SIGNIFICANT. BECAUSE OF THIS LIMITATION, THE IM-25 IS NOT A 'TRUE RMS' READING METER.
- WHEN CONNECTING THE IM-25 TO A CIRCUIT UNDER TEST, THE METER'S INTERNAL INPUT RESISTANCE AND INPUT CAPACITANCE (INPUT IMPEDANCE) IS EFFECTIVELY PLACED IN PARALLEL WITH THE VOLTAGE SOURCE, AND IN SOME CASES THIS CAN LOAD THE CIRCUIT UNDER TEST IN ODD WAYS THAT MAY ACTUALLY CHANGE THE FUNCTIONALITY OF THAT CIRCUIT. FOR LOWER FREQUENCIES, SUCH AS POWER LINE FREQUENCIES OF 60Hz OR 50Hz, THE EFFECTS OF THE CAPACITIVE LOADING SHOULD BE NEGLIGIBLE. BUT AT HIGHER FREQUENCIES, THE CAPACITIVE REACTANCE DECREASES; AT 10kHz, FOR EXAMPLE, THE CAPACITIVE REACTANCE IS APPROXIMATELY 100kΩ, AND SUCH A VALUE MIGHT SIGNIFICANTLY AFFECT THE MEASURED VOLTAGE AND/OR THE FUNCTIONALITY OF THE CIRCUIT UNDER TEST. HOWEVER, THIS IS NOT MUCH DIFFERENT FROM USING A MODERN SOLID STATE MULTIMETER TO MEASURE AC SIGNALS FROM CERTAIN SENSITIVE CIRCUITS.
- DUE TO THE HIGH INPUT IMPEDANCE, THE IM-25 CAB PICK UP STRAY ELECTRICAL FIELDS AND THE METER WILL INDICATE THIS PICKUP.

DC & AC CURRENT MEASUREMENTS:
- CURRENT UP TO 1.5A (1500mA) CAN BE MEASURED USING THE IM-25.
- VERY LOW CURRENTS (AS LOW AS 0.015mA FULL SCALE, SO EFFECTIVELY AS LOW AS 0.001mA or 1μA, ALBEIT WITH REDUCED ACCURACY) CAN ALSO BE MEASURED USING THE IM-25.
- IT IS CRITICAL THAT CURRENT MEASUREMENTS NOT BE MADE USING THE 'DC' VOLTS PROBE, SINCE ITS INTEGRAL 1MΩ RESISTOR WILL SIGNIFICANTLY SKEW THE CURRENT READING TO THE POINT OF EFFECTIVELY RESULTING IN NO READING, AND INTRODUCTION OF THAT RESISTANCE INTO THE CIRCUIT UNDER TEST IS LIKELY TO SERIOUS AFFECT ITS FUNCTIONALITY. ALWAYS USE THE PROBE DESIGNATED AS BEING FOR 'AC/OHMS' WHEN MAKING CURRENT MEASUREMENTS.
- THE 'CURRENT' ('mA') RANGE SWITCH HAS TWO SETS OF MARKINGS FOR EACH POSITION, FOR WHICH THE HEAVIER NUMBER REPRESENTS THE AMOUNT OF CURRENT (IN mA) THAT WILL RESULT IN A FULL SCALE METER MOVEMENT, WHILE THE LIGHTER NUMBER SHOWS THE AMOUNT OF RESISTANCE THE METER CIRCUIT ADDS TO THE CIRCUIT UNDER TEST.
- TO MEASURE DC CURRENT, PLACE THE 'FUNCTION' SWITCH IN THE 'mA' POSITION AND TURN THE 'MODE' SWITCH TO THE 'DC+' POSITION. SET THE 'mA RANGE' SWITCH TO THE POSITION THAT INDICATES A HIGHER FULL SCALE READING THAN THE CURRENT YOU INTEND TO MEASURE. MAKE SURE TO USE THE BLACK 'DC' METER SCALE FOR THE MEASUREMENT. IF THE AMOUNT OF CURRENT IS UNKNOWN, INTIALLY SET THE RANGE SWITCH TO ITS HIGHEST POSITION OF 1500mA, AND THEN SWITCH TO A LOWER RANGE ONCE THE INITIAL METER INDICATION SHOWS THAT IT IS SAFE TO DO SO. IF THE CURRENT BEING MEASURED IS NOT SUFFICIENT TO RESULT IN A READING OF AT LEAST 1/4 FULL SCALE, SWITCH TO THE NEXT LOWER RANGE.
- TO MEASURE AC CURRENT, USE THE SAME PROCEDURE AS DESCRIBED ABOVE FOR DC CURRENT, EXCEPT SET THE 'MODE' SWITCH TO THE 'AC' POSITION. MAKE SURE TO TAKE THE READINGS FROM THE RED 'AC' SCALE.
- NOTE THAT THE IM-25 DOES NOT HAVE ANY KIND OF FUSE PROTECTION AGAINST OVER-CURRENT. TRYING TO MEASURE CURRENTS HIGHER THAN 1.5A (1500mA) MAY DESTROY COMPONENTS, CIRCUIT BOARD TRACES, AND WIRING INSIDE THE METER.

RESISTANCE (OHMS) MEASUREMENTS:
- DO NOT ATTEMPT TO MEASURE RESISTANCE IN CIRCUITS IN WHICH POWER IS APPLIED, AND PREFERABLY DISCONNECT FROM THE CIRCUIT ONE LEAD OF THE RESISTOR UNDER TEST. IF MEASURING IN CIRCUITS WHICH HAVE LARGER VALUE AND/OR ELECTROLYTIC CAPACITORS, DISCHARGE THOSE FIRST BEFORE CONNECTING THE IM-25 PROBES TO THE CIRCUIT.
- THE IM-25 DOES NOT HAVE ANY INTERNAL PROTECTION AGAINST CIRCUIT DAMAGE IF VOLTAGES ARE ACCIDENTALLY MEASURED WHILE THE 'FUNCTION' SWITCH IS SET TO THE 'OHMS' POSITION. ALWAYS RE-CHECK THE METER SETTINGS AND TAKE CARE WHEN CONNECTING THE TEST PROBES TO ANY KIND OF COMPONENT OR CIRCUIT WHICH MAY HAVE POWER APPLIED TO IT, OR WHICH MAY STILL HAVE CHARGED CAPACITORS.
- SET THE 'FUNCTION' SWITCH TO ITS 'OHMS' POSITION. THE 'MODE' SWITCH (AC/DC-/DC+) HAS NO EFFECT WHEN THE METER IS IN THE 'OHMS' FUNCTION.
- SHORT THE 'AC/OHMS' PROBE TO THE BLACK TEST LEAD (GROUND) AND USE THE 'ZERO SET' THUMBWHEEL TO ZERO THE METER. UN-SHORT THE TEST LEADS AND VERIFY THAT THE METER MOVES UPSCALE TO THE MARK AT THE FAR RIGHT END OF THE GREEN SCALE.
- CONNECT THE PROBES TO THE RESISTANCE UNDER TEST, AND ADJUST THE 'OHMS RANGE' SWITCH FOR A READING IN THE LEFT HALF OF THE METER SCALE, IF POSSIBLE, FOR THE BEST ACCURACY IN THE READING. TO GET THE ACTUAL OHMS VALUE, MULTIPLY THE READING BY THE MULTIPLIER OF THE CURRENTLY SELECTED 'OHMS RANGE' SWITCH POSITION.
- THE METER PLACES A VOLTAGE OF 70mV OR LESS ACROSS THE RESISTANCE UNDER TEST. THIS LOW VOLTAGE PERMITS RESISTANCE MEASUREMENTS IN SOLID-STATE CIRCUITS, SINCE IT IS NOT SUFFICIENT TO CAUSE TRANSISTORS AND DIODES TO CONDUCT (IN WHICH CASE THEY WOULD ACT AS A SHUNT TO THE OHMMETER CIRCUIT). HOWEVER, DIODES CANNOT BE CHECKED FOR 'FRONT TO BACK RATIO' SINCE THE APPLIED VOLTAGE IS SO LOW THAT THE DIODE WILL NOT CONDUCT IN EITHER DIRECTION, AND A GOOD DIODE WILL APPEAR TO BE OPEN.
- SINCE THE IM-25'S OHMMETER CURCUITRY IS ALWAYS USING SOME BATTERY POWER WHILE THE 'FUNCTION' SWITCH IS IN ITS 'OHMS' POSITION, EVEN IF THE 'POWER' SWITCH IS TURNED OFF, DO NOT LEAVE THE METER IN THE 'OHMS' FUNCTION EXCEPT WHEN ACTUALLY READY TO TAKE RESISTANCE MEASUREMENTS. HOWEVER, IF THE BATTERY ELIMINATORS (DESCRIBED ELSEWHERE ON THIS SET OF DRAWINGS) ARE INSTALLED IN PLACE OF THE ORIGINAL BATTERIES, THEN IT IS OK TO LEAVE THE METER IN THE 'OHMS' FUNCTION INDEFINITELY.

ACCURACY:
- THE METER MOVEMENT ITSELF IS ACCURATE TO WITHIN +/- 2% OF FULL SCALE. FOR 'DC' FUNCTIONS. THE +/- 1% TOLERANCE OF THE ATTENUATOR DIVIDER RESISTORS MUST BE TAKEN INTO ACCOUNT, RESULTING IN AN OVERALL ACCURACY OF +/- 3% OF FULL SCALE. FOR THE 'AC' FUNCTIONS, THE SAME TOLERANCES APPLY, PLUS THE RECTIFIER CIRCUIT CONTRIBUTES TO AN OVERALL ACCURACY OF +/- 5% OF FULL SCALE. THE ABOVE APPLIES TO BOTH VOLTAGE AND CURRENT MEASUREMENTS.
- THE ACCURACY WHEN IN THE 'OHMS' FUNCTION DEPENDS PRIMARILY ON THE MULTIPLIERS WHICH ARE 1% AND THE METER MOVEMENT'S 2%. BECAUSE OF THE NON-LINEARITY OF THE 'OHMS' METER SCALE, THE RESULTING OVERALL ACCURACY IS NOT READILY EXPRESSED AS A PERCENTAGE FIGURE.

SAFETY:
- ESPECIALLY WHEN THE 'VOLTS RANGE' SWITCH IS SET TO ANY OF ITS LOWER RANGES, DO NOT TOUCH THE PROBE TIP WITH YOUR FINGERS WHEN MEASURING VOLTAGES. ALSO, REGARDLESS OF THE VOLTAGE RANGE, THESE IS A SAFETY CONCERN.
- THE IM-25 WAS NOT DESIGNED WITH ADEQUATE INTERNAL PROTECTION FOR OPERATION IN ENVIRONMENTS WITH HIGHER LEVELS OF RADIO FREQUENCY (RF) ENERGY PRESENT. AVOID USING IT WHEN IN CLOSE PROXIMITY TO RADIO TRANSMITTING EQUIPMENT, ETC.

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEET 2 OF THIS DRAWING

HEATHKIT IM-25
SOLID STATE VOM
SCHEMATIC DIAGRAM

REVISION A 3-25-2023