V/Ω
SHIELDED CABLE 1 'WHT'
D
JUMPER
E
F101 3/16A, AGX FAST BLOW
C
SHIELDED CABLE 2 'WHT'
S105
OFF
1000V
200V
20V
2V
200mV
R111 100k WW 1/2W 1%
R112 100k WW 1/2W 1%
S103
20M
2M
200k
20k
2k
200Ω
Z101
S104
R110, 1M "20M ADJ"
3 CW
1M
8.004M
896k
90k
90k
9003.5k
996.5
DC VOLTAGE ATTENUATOR AND OHMS CURRENT CONTROL
SEE DIAGRAM AT RIGHT
S106
Z101 PINOUT
8 7 6 5 4 3 2 1
(SHOWN SCHEMATICALLY AT LEFT)
S102
A/D CONVERTER FULL SCALE RANGE SELECT
+12V
R148 4.99k 1/4W 1%
+8V CW
R114 5k "ZERO ADJ"
-8V
R147 4.99k 1/4W 1%
-12V
LOW IMPEDANCE INTEGRATOR OFFSET ADJUST
R115 2k 1/4W 1%
R117 2k 1/4W 1%
R116 10 1/4W 1%
R118 500 "2VFS ADJ"
R113 17.8k 1/4W 1%
FUNCTION DCV/Ω
FUNCTION DCmA
"RAMP DOWN" (t2) -Iref CURRENT SINK
Q105 TD101
R136 14.3k 1/4W 1%
R137 2k "NEG RANGE"/"V-"
R135 12k
R134 825 1/4W 1%
CR109 6.2V-TC 0.5W 1N825(A)
R133 12k
400µA
Q104 2N5354
R132 62k
R131 12k
"RAMP DOWN" (t2) +Iref CURRENT SOURCE
Q107 TD401
R141 14.3k 1/4W 1%
R142 2k "POS RANGE"/"V+"
+12V
R143 12k
R140 825 1/4W 1%
CR110 6.2V-TC 0.5W 1N825(A)
R139 12k
400µA
Q106 2N2712
R138 12k
FROM LOGIC (SHEET 2) U212 PIN 14
FROM LOGIC (SHEET 2) U212 PIN 8
C109 1.75µF 50V 10% MYLAR
C108 220pF 50V 3% MICA
DUAL SLOPE ANALOG/DIGITAL CONVERTER
FULL SCALE VOLTAGE HERE IS +/- 0~0.2V OR +/- 0~2V
FUNCTION DCV/Ω
R145 100k 1/4W 1%
INTEGRATOR
U101 TIC60108
R144 1.5k 1/8W 1% OPTL
C107 0.0047pF 50V 5% MICA
C106 0.1µF 50V 10% MYLAR
Q101 SPS1317
Q102 SPS1317
Q101 & Q102 FUNCTION AS A PAIR OF BACK-TO-BACK 6.5V ZENER DIODES
INTEGRATOR INPUT OVERVOLTAGE CLAMP
TO LOGIC (SHEET 2) Q9 EMITTER
R128 10k 1/4W 1%
R129 10k 1/4W 1%
C104 100pF 50V
COMPARATOR
U103 µA710C
TO LOGIC (SHEET 2) U210 PIN8, ETC.
C102 0.0047µF 50V
R120 1.5k
U102 TOA8709
C101 22pF 50V 3% MICA
R122 1k 1/4W 1%
1mA
OHMS FUNCTION TEST CURRENT SOURCE
R124 909 1/4W 1%
R123 5.1k
Q103 2N2712
CR111 1N914
CR112 6.2V 0.4W 1N823(A)
R125 5.76k 1/4W 1%
R126 1k "OHMS CAL"
-12V

AC CONVERTER CIRCUIT BOARD

FUNCTION ACV
FUNCTION ACmA
C401 0.1µF 630V MYLAR
S401
AC VOLTAGE ATTENUATOR
R401 495k SEL
R402 495k SEL
R403 9000 SEL
R404 1000 SEL
R406 1M 1/2W 5%
C402 10pF 5% 600V
C403 2~8pF "LO CAL"
C404 430pF 300V MICA
C405 15~60pF "HI CAL"
C406 0.005µF 50V 5% MICA
NOTE: MAXIMUM AC INPUT VOLTAGE IS 500V, INCLUDING IN THE 1000V RANGE.
R405 49.9k 1/8W 1%
S402
AC VOLTAGE BUFFER
CR401 FD333
CR402 FD333
Q401 2N4304
Q402 2N4126
R407 22k
R408 6.8k
R409 90k SEL
R410 10k SEL
C418 15µF 25V TANT
U401 TOA8709
C415 39pF 50V MICA
R422 1.5k
C416 3pF 25V MICA
PRECISION RECTIFIER
C409 15µF TANT 25V
CR403 HP5082
CR404 HP5082
R411 10k 1/4W 1%
R414 10k 1/4W 1%
R415 10k 1/4W 1%
R413 50 "AC ADJ"
R412 511 1/4W 1%
R417 100k
R418 100k
C408 15µF TANT 25V
S107
AC CURRENT ATTENUATOR BYPASS
R416 9.13k 1/4W 1%
C419 15µF TANT 25V
C420 15µF TANT 25V
R423 SELECTED 1/8W 1%
C413 8.2µF TANT 25V
C414 8.2µF TANT 25V
U401 TOA8709(V)
R419 30.1k 1/4W 1%
R420 30.1k 1/4W 1%
R421 30.1k 1/4W 1%
C410 2.2µF TANT 25V
C411 1µF TANT 25V
C412 0.47µF TANT 25V
LOW PASS FILTER
R119 100k 1/4W 1%
FUNCTION DCmA
F102 3A, AGX FAST BLOW
AC/DC CURRENT OVERVOLTAGE CLAMP
mA
B
CR101 A15FX4
CR103 A15FX4
CR102 3A30
CR104 3A30
R101 22k
R102 22k
SHIELDED CABLE 2 'SHLD'
COM
SHIELDED CABLE 1 'SHLD'
R103 900 WW 3W 0.1%
R104 90 WW 3W 0.1%
R105 9 WW 3W 0.1%
R106 0.9 WW 3W 0.1%
R107 0.1 WW 2.5W 0.1% KELVIN
DC/AC CURRENT SHUNTS
ALL SHUNT VALUES ABOVE ARE GIVEN IN OHMS
GROUND CONNECTION FOR 'COM' TERMINAL IS MADE AT PAD 'A'
AC CONVERTER NOTE: THE WESTON SCHEMATIC SHOWS SEVERAL MEANINGLESS CONTACT CONNECTIONS/CLOSURES ON S401 & S402 IN THE 'OHMS' RANGES. THESE REFLECT ACTUAL CIRCUIT BOARD SWITCH CONNECTIONS WHICH ARE FOR BOARD LAYOUT CONVENIENCE, BUT WHICH ARE IRRELEVANT TO CIRCUIT OPERATION. SUCH SWITCH CONTACTS ARE IGNORED ON THIS VERSION OF THE SCHEMATIC.
THIS SYMBOL ⊘ (ON THIS SHEET ONLY) DENOTES A LETTER DESIGNATED PAD ON THE CIRCUIT BOARD WHERE WIRING AND/OR JUMPER(S), ASSOCIATED WITH CONNECTIONS TO THE FRONT PANEL TEST LEAD JACKS, CAN BE DIRECTLY SOLDERED.

+12V +12V +12V
V+ U101 TIC60108(V) V-
V+ U102 TOA8709(V) V-
V+ U103 µA710C GND V-
C110 0.01µF 50V
C103 0.01µF 50V
C105 0.01µF 50V
R130 1.5k
-12V

LOGIC CIRCUITRY IS SHOWN ON SHEET 2 OF THIS DRAWING

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEETS 3&4 OF THIS DRAWING

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE WESTON/SCHLUMBERGER 1240. 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.

WESTON/SCHUMBERGER 1240 DIGITAL MULTIMETER SCHEMATIC DIAGRAM

SHEET 1 OF 4

REVISION A 1-25-2024

THE HIGH VOLTAGE (HV) SUPPLY IS ACTUALLY A PULSING DC SIGNAL, WITH AN AVERAGE VALUE OF ABOUT 90VDC. THIS IS NOT FILTERED, AND IS PROBABLY BENEFICIAL TO THE NIXIE TUBES AS A MEANS TO REDUCE 'CATHODE POISONING'.

HV 90VDC

R201 30k — DS3/DS201 " UNITS " B5853S NIXIE TUBE
R202 30k — DS2/DS202 " TENS " B5853S NIXIE TUBE
R203 30k — DS1/DS203 " HUNDREDS " B5853S NIXIE TUBE

S101: OFF, 1000V/mA, 200V/mA, 20V/mA, 2V/mA, 200mV/µA, 200Ω, 2k, 20k, 200k, 2M, 20M

WIRED

U207 CµL9960 DECODER DRIVER
U208 CµL9960 DECODER DRIVER
U209 CµL9960 DECODER DRIVER

U204 CµL9959 BUFFER STORAGE
U205 CµL9959 BUFFER STORAGE
U206 CµL9959 BUFFER STORAGE

U201 CµL9958 DECADE COUNTER
U202 CµL9958 DECADE COUNTER
U203 CµL9958 DECADE COUNTER

CARRY

UNITS, TENS, HUNDREDS COUNTERS, ETC.

40kHz CLOCK OSCILLATOR

VCC +3.6V
R221 22.1k 1/4W 1%
R220 22.1k 1/4W 1%
R222 22k
U210
C207 0.001µF 100V 2%
C208 5-60pF "40kHZ ADJ"
C206 0.001µF 100V 2%
C209 SELECTED OPTL
CR203 S262 GERMANIUM

FROM ANALOG (SHEET 1) U101 PIN 6

R205 100k — DS4/DS204 A261 "1" — Q201 1N5175 — R208 2.4k
R207 100k — DS7/DS207 A1C "OVER" — Q204 1N5175 — R211 2.4k — CR201 2x 1N914 — CR202 — R212 560 — Q205 2N2712 — Q206 2N2712
R206 100k — DS6/DS205 A1C "+" — Q202 1N5175 — R209 2.4k
DS5/DS206 A1C "-" — Q203 1N5175 — R210 2.4k

THE NEON BULB INDICATOR CIRCUIT DIFFERS SOMEWHAT BETWEEN VERSIONS OF THE 1240. SOME VERSIONS USED RESISTOR VOLTAGE DIVIDERS TO REDUCE THE HV APPLIED TO EACH NEON BULB, SOME REPLACED CR201, CR202, Q205, Q206 WITH AN EXTRA IC, THE FAIRCHILD 91428, IN ITS ROUND 8 PIN PACKAGE. THE VERSION THAT MOST RESEMBLES THE 1240'S 'SISTER PRODUCT', THE HEATHKIT IM-102, IS THE ONE DEPICTED HERE.

FUNCTION DCV/Ω
FUNCTION DCmA

U213 MC778P — "1 STORAGE"
U215 MC776P — "OVER STORAGE"
U215 MC776P — "POL STORAGE"

U213 MC778P — ÷2
U214 MC778P — ÷2
U214 MC778P — ÷2
VCC +3.6V
R213 6.8k
R214 6.8k
U210
U211 — "8000 DETECT"

THOUSANDS COUNTER & 2000 & 4000 DIVIDER/COUNTERS

"1" & "OVER" STORAGE CONTROL

TO ANALOG (SHEET 1) Q104 BASE VIA R131
TO ANALOG (SHEET 1) Q106 BASE VIA R138

Iref CONTROL LOGIC
U212 U212 U212

DIGIT DISPLAY STORAGE CONTROL
Iref ENABLE

C201 220pF 100V 3% — R215 2.4k
C203 0.001µF 50V — R218 6.8k
RAMP DOWN LATCH
U211 U211
C202 0.001µF 50V — R216 2.4k
U210 U210

INTEGRATOR RAMP ZERO CROSSING DETECTED
FROM ANALOG (SHEET 1) U103 PIN7

ZERO CROSSING PULSE SHAPER
C204 0.001µF 50V
C205 0.001µF 50V
R217 2.4k
R219 2.4k
U210
U212

NOTE:
THE ORIGINAL WESTON SCHEMATIC FOR THE LOGIC SECTION OF THE CIRCUIT HAS A COUPLE ODDITIES IN ITS SYMBOLOGY:

ALL OF THE SECTIONS OF THE MC789 'HEX INVERTER' (U210) ARE SHOWN AS NON-INVERTING BUFFERS: ALTHOUGH THEY SHOULD BE:

ALL OF THE 'NOR' GATES IN THE MC717 (U212) AND MC724 (U211) ARE SHOWN AS 'AND' GATES: ALTHOUGH THEY SHOULD BE:

THIS MAY BE DUE TO AN AWKWARD ATTEMPT TO MAKE THE LOGIC SEEM LESS COMPLEX THROUGH REMOVAL OF INVERSIONS ACCORDING TO APPLICATION OF de MORGAN'S THEOREM. HOWEVER, IT IS ACTUALLY MORE LIKELY TO CAUSE CONFUSION SINCE THE DRAWN GATES DO NOT MATCH THE SYMBOLOGY OF THE IC'S. THIS RE-DRAWN SCHEMATIC USES THE 'OFFICIAL' LOGIC SYMBOLOGY.

NOTE:
THE DIGITAL CIRCUITRY ON THE 1240 IS ENTIRELY COMPRISED OF 'RTL' (RESISTOR-TRANSISTOR LOGIC), RATHER THAN THE LATER TTL AND CMOS TYPES.

EACH RTL LOGIC 'GATE' WAS BUILT USING RESISTORS AS THE INPUT NETWORK LOGIC AND BIPOLAR JUNCTION TRANSITORS (BJTs) AS THE SWITCHING DEVICES. RTL IS THE EARLIEST CLASS OF TRANSISTORIZED DIGITAL LOGIC CIRCUIT, DATING FROM 1961. FAMOUSLY, THE APOLLO SPACECRAFT GUIDANCE COMPUTERS WERE BASED ON RTL LOGIC ICs.

RTL USES A + POWER SUPPLY OF TYPICALLY 3.6V, RATHER THAN TTL'S MORE FAMILIAR 5V OR THE 3.3V COMMON WITH MODERN LOW VOLTAGE CMOS (LVCMOS), AND THE LOGIC LEVELS ARE 0V FOR LOGIC 'LOW' AND 3.5V FOR LOGIC 'HIGH'. THE 'NOR' GATE IS THE SIMPLEST TYPE, USING ONLY ONE TRANSISTOR, HOWEVER A LATER IMPROVED TOPOLOGY USES ONE TRANSISTOR FOR EACH INPUT OF THE NOR GATE.

RTL WAS SIMPLE, BUT HAD LIMITING DISADVANTAGES SUCH AS HIGH POWER CONSUMPTION AND HEAT GENERATION IN THE RESISTORS AND TRANSISTORS, AND A TYPICAL MAXIMUM NUMBER OF THREE INPUTS PER GATE DUE TO NOISE ISSUES, AND A VERY SMALL FAN-OUT (NUMBER OF OTHER GATE INPUTS DRIVEN BY A GATE OUTPUT).

VCC +3.6V

U201 CµL9958	U202 CµL9958	U203 CµL9958	U204 CµL9959	205 CµL9959	U206 CµL9959	U207 CµL9960	U208 CµL9960	U209 CµL9960	U210 MC789P	U211 MC724P	U212 MC717P	U213 MC778P	U214 MC778P	U215 MC776P
14	14	14	16	16	16	16	16	16	11	11	11	11	11	11
VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC	VCC
GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND
7	7	7	8	8	8	8	8	8	4	4	4	4	4	4

ANALOG CIRCUITRY IS SHOWN ON SHEET 1 OF THIS DRAWING

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEETS 3&4 OF THIS DRAWING

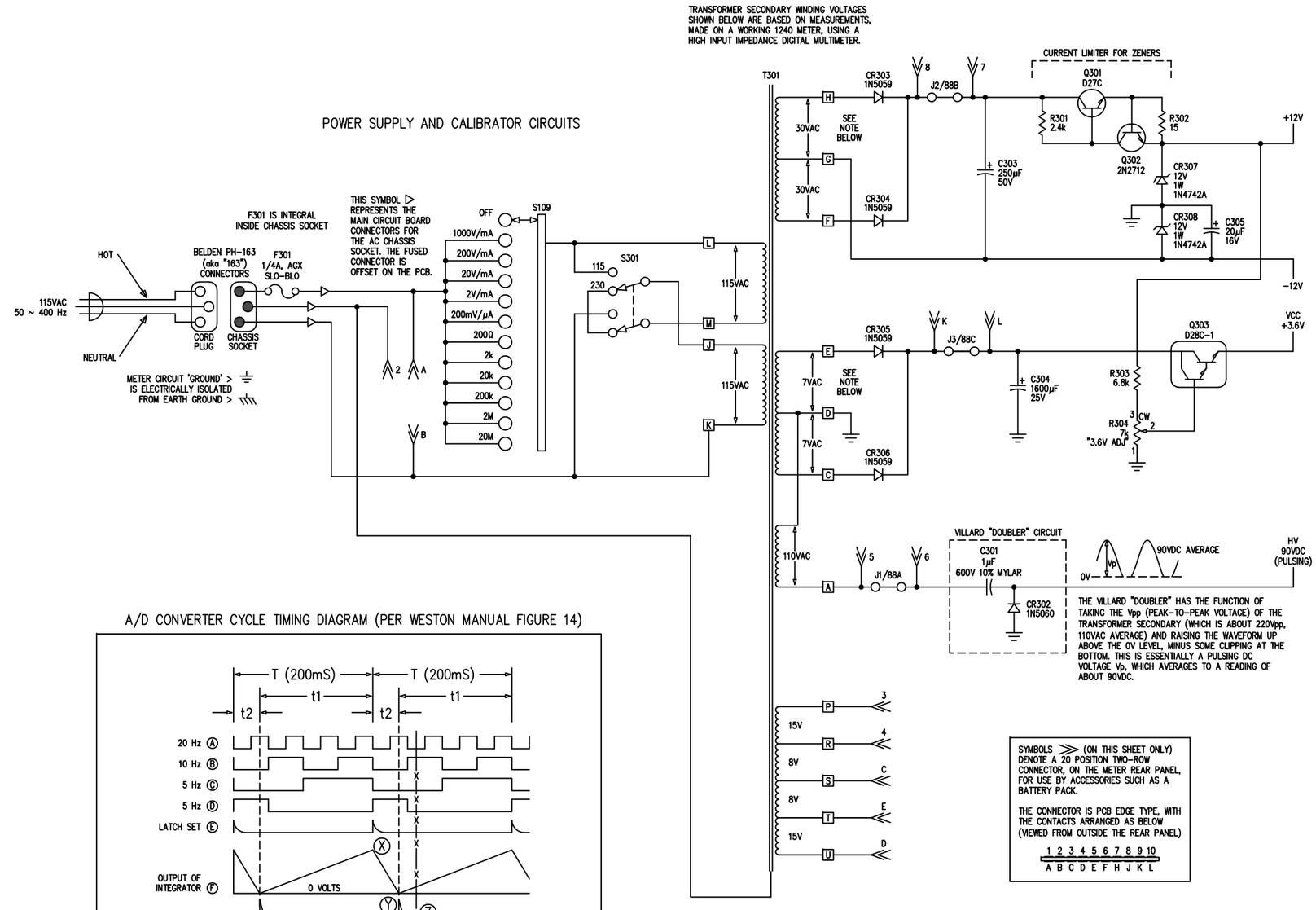
THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE WESTON/SCHLUMBERGER 1240. AN EFFORT HAS BEEN MADE TO SIZE AND SCALE COMPONENTS AND TEXT FOR THE LARGEST AND BEST VISIBILITY AND LEGIBILITY WHILE STILL FITTING ON A NORMAL 11 X 17" SHEET OF PAPER.

WESTON/SCHUMBERGER 1240 DIGITAL MULTIMETER SCHEMATIC DIAGRAM

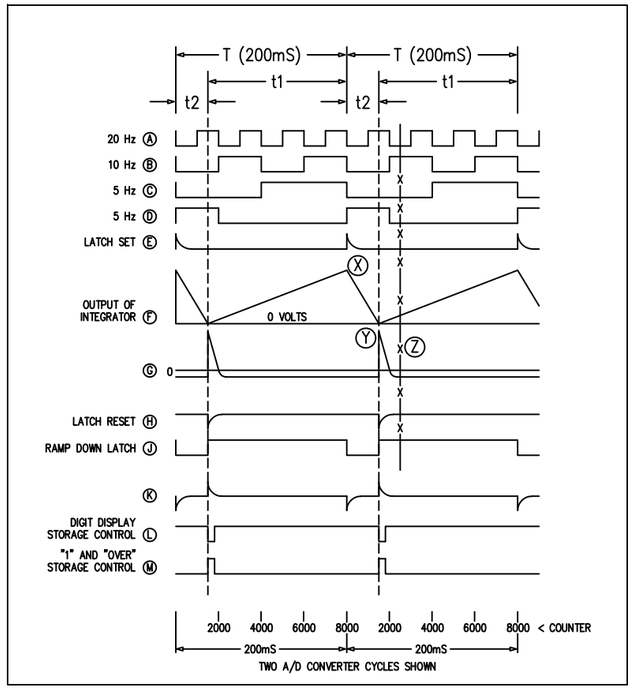
SHEET 2 OF 4

REVISION A 1-25-2024

POWER SUPPLY AND CALIBRATOR CIRCUITS



A/D CONVERTER CYCLE TIMING DIAGRAM (PER WESTON MANUAL FIGURE 14)



LETTERED CIRCLES LIKE THIS Ⓐ (A ~ M ONLY) CORRESPOND TO SIMILAR MARKINGS ON THIS DRAWING'S SHEETS 1 & 2

ACTIVE COMPONENT IDENTIFICATION AND SUBSTITUTES

DIODES

IDENTIFIER	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
CR101, 103	A15FX4	BY550-100	GP RECTIFIER DIODE, PIV=100V, 5A
CR102, 104	3A30	1N5403	SILICON DIODE, PIV=300V, 3A
CR302	1N5060		GP RECTIFIER DIODE, PIV=400V, 1A
CR303, 304, 305, 306	1N5059	1N5060	GP RECTIFIER DIODE, PIV=200V, 1A
CR111,201, 202	1N914	1N4148	SMALL SIGNAL, FAST SWITCHING, PIV=100V, 500mA
CR203	S262	1N191	GERMANIUM DIODE, PIV=90V, 500mA
CR401, 402	FD333	FDH333/1N3595	SILICON DIODE, PIV=125V, 150mA, FAST
CR403, 404	HP5082-2800	1N5711	SILICON SCHOTTKY DIODE, PIV=70V, 15mA

ZENER DIODES

IDENTIFIER	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
CR112	1N823	1N823A	6.2V ZENER, 400mW
CR109, 110	1N825A		6.2V ZENER, 500mW, TEMP COMPENSATED
CR307, 308	1N4742A		12V ZENER, 1W

TRANSISTORS

IDENTIFIER	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
Q101, 102	SPS1317		PNP BJT, FUNCTIONS AS A 6.5V 3mA ZENER
Q103, 106, 205, 206, 302	2N2712		NPN BJT, 18V, 100mA
Q104	2N5354		PNP BJT
Q402	2N4126	2N3906	PNP BJT
Q105	SPRAGUE TD101		DUAL NPN BJT, MAX: VCBO=60V,VCEO=30V,VEBO=5V
Q107	SPRAGUE TD401		DUAL PNP BJT, MAX: VCBO=40V,VCEO=30V,VEBO=5V
Q201, 202, 203, 204	2N5175	2N2509	NPN BJT, HI VOLT, MAX: VCBO=124V,VCEO=80V,VEBO=7V
Q301	D27C	2N5294	NPN BJT, POWER, TO-220, VCBO=80V,VCEO=70V,Ic=4A MAX
Q303	D40C1	D28C1	NPN BJT DARLINGTON, TO-202, VCB=80V,VCEO=30V,Ic=0.5A
Q401	2N4304		N-CHANNEL JFET

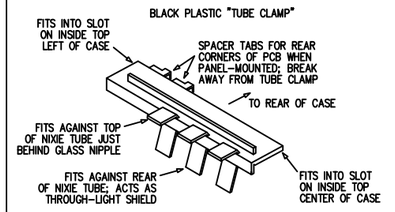
SOME OF THE SUGGESTED SUBSTITUTE TRANSISTORS HAVE PIN-OUTS THAT DIFFER FROM THE ORIGINAL PARTS, REQUIRING THAT THE PINS BE SHAPED AND POSSIBLY CROSSED-OVER IN ORDER TO CORRECTLY MATCH THE CIRCUIT BOARD HOLES.

DISPLAYS

IDENTIFIER	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
DS201, 202, 203	B-5853S	NL-5853S	NIXIE COLD-CATHODE TUBE (BURROUGHS & NATIONAL)
DS205, 206, 207	A1C		NEON LAMP, USED FOR "+" AND "-" AND "OVER"
DS204	A261		NEON LAMP, USED FOR "1" (THOUSANDS)

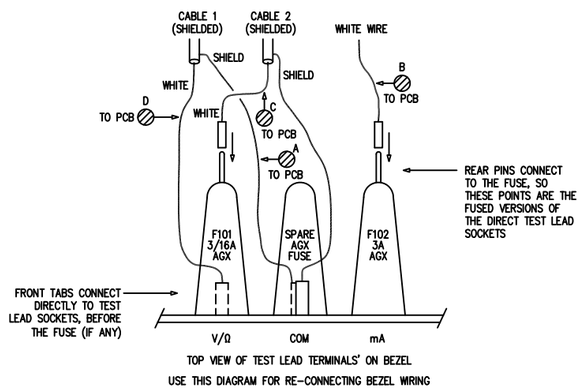
WESTON DOCUMENTS DISAGREE BETWEEN THEMSELVES REGARDING COMPONENT IDENTIFIERS FOR NEON BULBS AND NIXIE TUBES. THE MOST COMMON IDENTIFIERS ARE SHOWN IN THE TABLE ABOVE. SHEET 2, IN ADDITION TO THE COMMON IDENTIFIERS, INCLUDES THE LESS COMMON IDENTIFIERS, e.g. DS3/DS201.

INTEGRATED CIRCUITS (ICs) ARE NOT LISTED HERE, SINCE THEY HAVE NO PRACTICAL MODERN SUBSTITUTES (BEING OLD 'RTL' TYPES), AND ARE DESCRIBED ADEQUATELY ON THE OTHER SCHEMATIC DRAWINGS.



THIS ODD-SHAPED BLACK PLASTIC PIECE CAN OFTEN BE FOUND ON THE FLOOR AFTER PULLING THE CIRCUIT BOARD (PCB) OUT OF THE METER CASE, AS IT TENDS TO FALL OUT WITHOUT BEING NOTICED; WESTON CALLS IT THE "TUBE CLAMP". IT SERVES TO PREVENT THE THREE NIXIE TUBES FROM COMING OUT OF THEIR SOCKETS, AND ALSO HELPS VIEWING OF THE TUBES BY BLOCKING AMBIENT LIGHT FROM PASSING THROUGH THE TUBES AND ILLUMINATING PCB COMPONENTS, ETC; IT IS QUITE TRICKY TO RE-INSTALL; WHEN SLIDING THE PCB BACK INTO THE CASE, JUST WHEN THE 'AC CONVERTER" DAUGHTER BOARD CLEARS THE CENTRAL RIB ON THE INSIDE TOP OF THE CASE, EXPOSING A SLOT FOR THE TUBE CLAMP, SLIDE THE TUBE CLAMP IN BEHIND THE NIXIE TUBES AND MAKE SURE BOTH OF ITS ENDS FIT INTO THEIR SLOTS IN THE INSIDE TOP OF THE CASE, THEN CONTINUE SLIDING THE PCB INTO THE CASE.

THE TWO SPACER TABS CAN OPTIONALLY BE BROKEN AWAY FROM THE TUBE CLAMP (THEY MIGHT BE MISSING), AND THEN SNAPPED ONTO THE REAR CORNERS OF THE PCB NEAR THE ANCHORING SLOTS. THIS IS ONLY DONE WHEN THE METER IS GOING TO BE PANEL-MOUNTED.



TOP VIEW OF TEST LEAD TERMINALS' ON BEZEL

USE THIS DIAGRAM FOR RE-CONNECTING BEZEL WIRING

ANALOG & DIGITAL CIRCUITRY IS SHOWN ON SHEETS 1&2 OF THIS DRAWING

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEET 4 OF THIS DRAWING

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE WESTON/SCHLUMBERGER 1240. 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.

WESTON/SCHUMBERGER 1240 DIGITAL MULTIMETER SCHEMATIC DIAGRAM

SHEET 3 OF 4

REVISION B 2-4-2024

GENERAL NOTES (APPLICABLE TO ALL SHEETS OF THIS DRAWING)

THE NOTES BELOW ARE BASED ON A STUDY OF WESTON 1240 DIGITAL MULTIMETER AND A WESTON 1240 MANUAL, AS WELL AS THE ARTIFACT AND MANUAL FOR THE NEARLY IDENTICAL HEATHKIT IM-102 METER.

1) RESISTORS ARE CARBON COMPOSITE (CC) 1/4W, 5% UNLESS MARKED DIFFERENTLY. RESISTOR VALUES WITHOUT A KILO (k) OR MEGA (M) SUFFIX ARE IN OHMS (Ω); THAT SYMBOL IS SHOWN AS LITTLE AS POSSIBLE HEREIN SINCE IT LOOKS TOO MUCH LIKE OTHER ROUND LETTERS/NUMERALS. 'WW' SUFFIX MEANS WIRE-WOUND RESISTOR. RESISTORS MARKED AS "1/4W 1%" OR "1/2W 1%" APPEAR TO BE FILM TYPE, BUT MIGHT BE ANOTHER TYPE. 'KELVIN' MEANS A RESISTOR WITH TWO LEADS AT EACH END; THE MAIN CURRENT PASSES THROUGH THE RESISTOR USING ONE OF THE LEADS AT EACH END, WITH THE REMAINING TWO LEADS BEING USED TO MEASURE THE VOLTAGE DROP ACROSS THE RESISTOR. 'SEL' MEANS THAT THE RESISTOR WAS FACTORY SELECTED FOR BEST ACCURACY.
2) ALL TRIM POTS AND THEIR PCB CONNECTIONS HAVE BEEN INSPECTED AND THIS NEW SCHEMATIC CONFORMS TO THE PHYSICAL REALITY. ALSO, WESTON'S SCHEMATIC DOES NOT SHOW WHICH DIRECTION ON TRIM POTS IS CLOCKWISE (CW); THAT INFORMATION HAS BEEN ADDED HEREIN. ALL TRIM POTS EXCEPT R110 "20M ADJ" AND R304 "3.6V ADJ" ARE EITHER 10 TURN OR 15 TURN TYPES.
3) WESTON DID NOT SPECIFY MOST CAPACITOR VOLTAGES IN THE MANUAL, AND STUDY OF A WORKING 1240 METER REVEALED THAT MOST CAPACITORS WERE NOT PHYSICALLY MARKED WITH THEIR VOLTAGE. WHERE CAPACITOR VOLTAGES ARE SHOWN ON THIS SCHEMATIC, THEY ARE (FOR THE MOST PART) BEST GUESSES BASED ON AVAILABLE EVIDENCE. CAPACITORS ARE CERAMIC DISK TYPE UNLESS INDICATED OTHERWISE. CAPACITORS SHOWN AS POLARIZED (WITH +) ARE ELECTROLYTIC TYPE UNLESS INDICATED OTHERWISE.
4) CERTAIN SMALL POLARIZED CAPACITORS, ON PHYSICAL INSPECTION, APPEAR TO BE ENCAPSULATED TANTALUM TYPES, AND ARE IDENTIFIED AS SUCH ON THIS NEW DOCUMENTATION.
5) ALL SWITCHES SHOWN ARE ALL PART OF EITHER THE 'RANGE' SWITCH (RS), IN GANGS S101~S109 AND S401~S402, OR THE FUNCTION SWITCH. FOR CLARITY, THIS RE-DRAWN SCHEMATIC SEPARATES MOST GANGS/WAFERS OF 'RS' INTO SECTIONS WHENEVER THE FUNCTIONALITY DIFFERS BETWEEN TWO OR MORE PORTIONS OF THE GANG/WAFER; THIS IS DEPICTED WITH A DIAGONAL PAIR OF LINES SHOWING THE 'BREAK'. ON THE RANGE SWITCH (RS), FOR THE POSITIONS PERTAINING TO VOLTAGE OR CURRENT, EACH INCIDENCE OF THESE ON THIS SCHEMATIC IS MARKED WITH ONLY THE PERTINENT UNITS (V OR mA), UNLESS A PARTICULAR PART OF THE SWITCH SERVES FOR BOTH TYPES OF UNITS.
6) COMPONENTS MARKED "OPTL" MIGHT BE OMITTED AT THE FACTORY'S DISCRETION. IF AN "OPTL' COMPONENT IS NORMALLY IN SERIES WITH ANOTHER COMPONENT, BUT THE 'OPTL' COMPONENT HAS BEEN OMITTED IN A PARTICULAR METER, THEN THE REMAINING COMPONENT IS CONNECTED TO SPAN THE CONNECTION POINTS FOR BOTH COMPONENTS. THIS IS SOMETIMES DONE FOR FACTORY 'TUNING' OF CERTAIN CIRCUIT NODES.
7) A ROUND SYMBOL WITHOUT NUMBER, e.g. ◯ CORRESPONDS TO TERMINALS ON THE RANGE SWITCH. WHERE THIS SYMBOL APPEARS SEPARATELY FROM A SWITCH, THIS MEANS THAT IT IS A COMMON PIN SHARED BY TWO SECTIONS OF THE SAME SWITCH GANG/WAFER, AS SHOWN ON THE SCHEMATIC.
8) A ROUND SYMBOL WITH A SINGLE LETTER, e.g. Ⓐ CORRESPONDS TO 'A/D CONVERTER' TIMING CYCLE WAVEFORMS AS SHOWN IN WESTON MANUAL FIGURE 14 (REPRODUCED IN THIS DRAWING SET ON SHEET 3).
9) SOME SECTIONS OF RANGE SWITCH 'RS' HAVE NONSENSICAL CONTACT CONFIGURATIONS, PROBABLY RESULTING FROM UNUSED REMNANTS OF THE SWITCH STRUCTURE WHICH WERE LEFT IN PLACE OUT OF CONVENIENCE. SWITCH CONTACT ARRANGEMENTS WHICH HAVE BEEN IDENTIFIED AS USELESS AND CONFUSING HAVE BEEN OMITTED IN THESE NEW DRAWINGS.
10) SOME RANGE SWITCH POSITIONS ARE USED FOR BOTH VOLTAGE AND CURRENT MEASUREMENTS, AND THUS ARE MARKED ON THE MATER FRONT PANEL WITH THE NUMERICAL PART OF THE RANGE ONLY. FOR EXAMPLE, '1000' MEANS EITHER 1000V OR 1000mA. IN THE CASE OF THE LOWEST VOLTS/CURRENT RANGE, THE DIFFERENCE IS SPELLED OUT AS 200mV AND 200µA, SINCE THE UNITS ARE DIFFERENT. THE OHMS (RESISTANCE) RANGES DO NOT DO DOUBLE-DUTY.
11) CONTACTS THAT ARE PART OF FUNCTION SWITCH (FS) ARE DESIGNATED WITH TERMINALS IDENTIFIED WITH NUMBERS AND ARE CONSISTENT WITH THE WESTON SCHEMATIC DESIGNATIONS. THIS NEW SCHEMATIC SHOWS ONLY THE PERTINENT CONTACT INFORMATION ACCORDING TO WHICH SWITCH POSITION WILL RESULT IN THE ASSOCIATED SWITCH CONTACT CLOSING.
12) A SQUARE SYMBOL WITH A LETTER, e.g. [A] CORRESPONDS TO HOLES IN THE PCB WHERE POWER TRANSFORMER WIRE TERMINATIONS ARE CONNECTED. LETTERS A, C~H, J~M, P, R~U ARE USED.
13) POWER SUPPLY PINS ON THE IC'S HAVE HEREIN BEEN SHOWN GROUPED TOGETHER NEAR THE BOTTOMS OF THE APPLICABLE SHEETS, RATHER THAN HAVE THEM CLUTTERING UP THE REST OF THE FUNCTIONAL SCHEMATICS.
14) COMPONENT DESIGNATIONS OF CAPACITORS AND RESISTORS ARE 'GEOGRAPHICAL' IN THAT THEIR MOST SIGNIFICANT DIGIT DESIGNATES WHICH SECTION OF THE OVERALL CIRCUIT THEY BELONG TO. USING RESISTORS AS AN EXAMPLE, R1XX PARTS ARE USED IN THE ANALOG CIRCUITRY, R2XX PARTS ARE USED IN THE DIGITAL CIRCUIT, R3XX ARE IN THE POWER SUPPLY CIRCUIT (ALL OF THESE SO FAR ARE ON THE MAIN PCB), R4XX ARE ON THE 'AC CONVERTER' CIRCUIT BOARD. THE SAME PREFIX ASSOCIATIONS ARE APPLICABLE TO CAPACITORS AND SEMICONDUCTORS. HOWEVER, SWITCHES, DISPLAY COMPONENTS, ETC' DO NOT FOLLOW THE GEOGRAPHICAL LOCATION SCHEME.
15) WHILE THE FRONT PANEL IS MARKED WITH A '1000' RANGE, SUGGESTING BOTH 1000V AND 1000mA MAXIMUM READINGS, THE ACTUAL MAXIMUMS ARE: (DCV) +/-1000V, (ACV) 500V, (DCmA & ACmA) 2000mA (ACTUALLY READS UP TO 1999mA).
16) THE IM-102 IS HEATH'S CLONE OF THE FUNCTIONALLY IDENTICAL WESTON (AND SCHUMBERGER) 1240 DIGITAL MULTIMETER. BOTH HEATH AND WESTON WERE PART OF THE SAME PARENT COMPANY AT THE TIME THESE MODELS WERE DEVELOPED. THE ELECTRONIC CIRCUITRY IS VIRTUALLY IDENTICAL BETWEEN THE TWO. THE "ACTIVE COMPONENT IDENTIFICATION AND SUBSTITUTES" CHARTS ON SHEET 3 OF THIS DRAWING SET SHOWS THE WESTON ORIGINAL PART NUMBERS AS WELL AS THE EQUIVALENT HEATHKIT PARTS (IF STILL AVAILABLE) AND ALSO OTHER SUGGESTED REPLACEMENT PARTS.
17) IN A FEW PLACES, WESTON USED FACTORY SELECTED COMPONENTS TO ACHIEVE CALIBRATION, RATHER THAN USING ADJUSTABLE ONES; THESE ARE DENOTED 'SELECTED' ON THE SCHEMATICS.

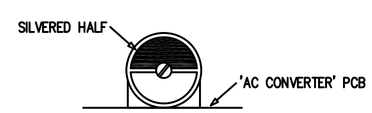
TO ACCESS THE INSIDE OF THE METER, FIRST REMOVE THE FRONT BEZEL; INSERT A FLAT-BLADE SCREWDRIVER TIP INTO THE SMALL SLOTS ON EACH SIDE OF THE BEZEL WHERE IT MEETS THE MAIN CASE, WITH THE SCREWDRIVER HANDLE TOWARDS THE REAR, AND TAP THE SCREWDRIVER IN A FORWARD DIRECTION TO DISENGAGE THE BEZEL FROM THE CASE - DO NOT TWIST THE SCREWDRIVER, AS DOING SO WILL DAMAGE THE PLASTIC. PULL THE BEZEL CLEAR (SOME WIRES WILL STILL BE ATTACHED), TAKING CARE TO NOT DAMAGE THE TINY METAL FINGERS ON THE REAR OF THE FUNCTION SWITCH. THE SHAFT OF THE RANGE SWITCH SHOULD SLIDE OUT OF THE KNOB, BUT IT MIGHT INSTEAD TRY TO SLIDE FORWARD OUT OF THE SWITCH; SIMPLY PUSH IT BACK UNTIL IT CANNOT GO IN ANY MORE (THE REAR END OF THE SHAFT TOUCHES THE POWER TRANSFORMER). TURN THE TWO SCREWS ON EITHER SIDE OF THE REAR PANEL COUNTER-CLOCKWISE A COUPLE ROTATIONS; THESE SCREWS PASS THROUGH THE PLASTIC CASE AND THREAD INTO TWO SMALL METAL ANCHORING TABS, WHICH IN TURN ENGAGE TWO SLOTS IN THE REAR OF THE MAIN CIRCUIT BOARD. TURNING THE SCREWS COUNTER-CLOCKWISE LOOSENS THE TABS FROM THE CIRCUIT BOARD SLOTS, AND ONCE LOOSENED, FURTHER COUNTER-CLOCKWISE SCREW ROTATION CAUSES THE TABS TO ROTATE OUT OF THE SLOTS, FREEING THE MAIN CIRCUIT BOARD TO SLIDE FORWARD OUT OF THE CASE. IT SHOULD NOT BE NECESSARY TO ROTATE THE SCREWS MORE THAN A COUPLE TURNS. THEIR POSITIONS CAN BE SEEN BY LOOKING INTO THE FRONT OF THE OPEN CASE.

LATER, WHILE SLIDING THE MAIN CIRCUIT BOARD BACK INTO THE CASE, TAKE CARE TO FOLLOW THE "TUBE CLAMP" INSTRUCTIONS ON SHEET 3. THEN WHEN THE CIRCUIT BOARD IS FULLY BACK INTO THE CASE, TURNING THE TWO SCREWS CLOCKWISE WILL FIRST ROTATE THE TABS BACK INTO THE CIRCUIT BOARD SLOTS, AND ONCE THE TABS CANNOT ROTATE FURTHER, CONTINUED TURNING OF THE SCREWS TIGHTENS THE TABS, DRAWING THE CIRCUIT BOARD FULLY INTO THE CASE AND ANCHORING IT. DO NOT OVER-TIGHTEN THE SCREWS. ALIGN THE RANGE SWITCH KNOB WITH ITS SHAFT AND CAREFULLY SNAP THE BEZEL BACK ONTO THE FRONT OF THE CASE.

THE AC POWER CORD SOCKET REMAINS ATTACHED TO THE CASE, AND ENGAGES WITH THREE CIRCUIT BOARD CONNECTORS FOR HOT, NEUTRAL, AND GROUND; THE 'HOT' CONNECTOR IS FURTHER INBOARD THAN THE OTHER TWO DUE TO THE FUSE.

ABBREVIATED CALIBRATION PROCEDURE

1) MEASURE THE LOGIC SUPPLY VOLTAGE BETWEEN CIRCUIT GROUND AND THE EMITTER OF DARLINGTON TRANSISTOR Q303; IT MAY BE EASIER TO TAKE THE MEASUREMENT BETWEEN THE POWER SUPPLY PINS OF ANY OF THE LOGIC IC'S, e.g. U201 PIN 7 (GROUND) AND PIN 14 (VCC); THE VOLTAGE SHOULD BE 3.6V. THERE ARE ALSO VOLTAGE TEST POINT PADS ON THE MAIN CIRCUIT CIRCUIT BOARD, LOCATED NEAR THE TWO LARGE FILTER CAPACITORS, MARKED "+3.6V" AND "⏚". IF NECESSARY, ADJUST LOGIC SUPPLY TRIM POT 'R304' (LOCATED BETWEEN THE TWO TEST POINT PADS) TO ACHIEVE THIS VOLTAGE.
2) THE WESTON MANUAL PROVIDES LITTLE ADVICE FOR CALIBRATION. ACCORDINGLY, A MODERN CALIBRATION PROCEDURE, WRITTEN FOR THE SIMILAR HEATHKIT IM-102, IS PRESENTED BELOW. IT HAS BEEN SOMEWHAT SIMPLIFIED AND ORIENTED TOWARDS RE-CALIBRATION OF IM-102'S (AND BY EXTENSION, 1240'S) THAT HAVE ALREADY BEEN VERIFIED AS OPERATIONAL AND PREVIOUSLY CALIBRATED, AND ARE NOW ONLY TO BE RE-CALIBRATED, PERHAPS AFTER REPAIR AND/OR RESTORATION. AVAILABILITY OF BASIC LABORATORY EQUIPMENT IS ASSUMED. WHEN SETTINGS SUCH AS '200mV/DCVΩ' ARE SHOWN, THEY ARE TO BE INTERPRETED AS 'RANGE SWITCH SET TO 200mV AND FUNCTION SWITCH SET TO DCVΩ'. THE PROCEDURE ASSUMES THAT THE METER CIRCUIT IS PROPERLY FUNCTIONING; FAILURE TO ACHIEVE THE RESULTS SPECIFIED IN THESE STEPS PROBABLY INDICATES THAT SOME ASPECT OF THE METER CIRCUIT REQUIRES TROUBLESHOOTING.
3) SHORT TOGETHER V/Ω AND COM FRONT PANEL JACKS. SET 200mV/DCVΩ , ROTATE "ZERO ADJ" TRIM POT 'R114' (ACCESSED THROUGH A HOLE IN THE FRONT PANEL AT THE LOWER RIGHT CORNER OF THE DISPLAY) FOR A METER READING OF 00.0 AND ALTERNATING +/- POLARITY INDICATIONS.
4) CONNECT A FREQUENCY COUNTER OR OSCILLOSCOPE INPUT TO THE METER'S U210 PIN 5 (PIN 4 OR ANOTHER CIRCUIT GROUND POINT IS THE REFERENCE); A SQUARE WAVE FREQUENCY OF NEAR 40kHz IS BEING MEASURED, SO SET THE COUNTER/SCOPE ACCORDINGLY. ROTATE THE "40kHz ADJ" TRIM CAPACITOR C208 (LOCATED ON THE MAIN CIRCUIT BOARD ADJACENT TO IC 'U204') UNTIL 40kHz IS ACTUALLY MEASURED.
5) CONNECT THE V/Ω AND COM TEST LEADS TO AN ACCURATE 200mVDC STANDARD, WITH THE (V/Ω RED) TEST LEAD TO THE POSITIVE SIDE OF THE SOURCE. SET 200mV/DCVΩ . ROTATE THE "POS RANGE" TRIM POT 'R142' (ACCESSED THROUGH A HOLE IN THE METER'S REAR PANEL MARKED "+V") FOR A READING OF 'OVER +00.0'. IF THE DISPLAY INCREASES (COUNTS UP) CONTINUOUSLY, THIS SUGGESTS A POOR CONNECTION WITH THE TEST SETUP.
6) CONNECT THE V/Ω AND COM TEST LEADS TO AN ACCURATE 200mVDC STANDARD, WITH THE (V/Ω RED) TEST LEAD TO THE NEGATIVE SIDE OF THE SOURCE. SET 200mV/DCVΩ . ROTATE THE "NEG RANGE" TRIM POT 'R137' (ACCESSED THROUGH A HOLE IN THE METER'S REAR PANEL MARKED "-V") FOR A READING OF 'OVER -00.0'.
7) REPEAT STEPS 5 & 6 TO VERIFY ALL IS WELL SO FAR.
8) CONNECT THE V/Ω AND COM TEST LEADS TO AN ACCURATE 2VDC STANDARD, WITH THE (V/Ω RED) TEST LEAD TO THE POSITIVE SIDE OF THE SOURCE. SET 2V/DCVΩ . ROTATE THE "2VFS" TRIM POT 'R118' (LOCATED ON THE MAIN PCB NEXT TO THE RANGE SWITCH) FOR A READING OF 'OVER +.000'.
9) CONNECT THE V/Ω AND COM TEST LEADS TO AN ACCURATE 20kΩ STANDARD (WITHIN 0.05% TOLERANCE). SET 20kΩ/DCVΩ . ROTATE THE "20k ADJ" TRIM POT 'R126' (ACCESSED THROUGH A HOLE IN THE METER'S REAR PANEL MARKED "Ω") FOR A READING OF 'OVER 0.00'. IF A PRECISION REFERENCE RESISTOR IS NOT AVAILABLE, SELECT A STABLE RESISTOR WITH A VALUE SLIGHTLY LESS THAN 20kΩ, AND MEASURE ITS RESISTANCE WITH AN ACCURATE MULTIMETER, THEN WITH THE RESISTOR CONNECTED TO THE IM-102, ROTATE "20k ADJ" TRIM POT 'R126' FOR A READING MATCHING THAT OF THE OTHER METER.
10) PERFORM THE SAME PROCEDURE AS WITH STEP 9 ABOVE, BUT USE A 20M REFERENCE RESISTOR, AND SET 20MΩ/DCVΩ ROTATE THE "20M ADJ" TRIM POT 'R110' (ACCESSED THROUGH A HOLE IN THE METER'S REAR PANEL MARKED "20 MEG") FOR A READING OF 'OVER 0.00'. DUE TO THE HIGH RESISTANCE AND LOW CURRENT, 30 OR 40 SECONDS MAY ELAPSE BEFORE A STABLE, ACCURATE READING IS OBTAINED ON THE 1240. DO NOT HOLD THE TEST LEADS IN YOUR HANDS FOR THIS STEP; USE CLIPS TO MAKE THE CONNECTIONS TO THE RESISTOR. AS WITH STEP 9, YOU CAN INSTEAD MEASURE SOME OTHER REFERENCE THAT IS SOMEWHAT LESS THAN 20M AND USE THAT AS A REFERENCE VALUE. REPEAT STEPS 9 & 10 TO VERIFY ALL IS STILL OK WITH THE CAILBRATION.
11) USE ANOTHER MULTIMETER TO MEASURE A CLEAN, SINUSOIDAL AC VOLTAGE, FOR EXAMPLE FROM THE LINE VOLTAGE OR FROM A FUNCTION GENERATOR SET TO OUTPUT AN AC SINCE WAVE SIGNAL. WRITE DOWN THE VOLTAGE READING. IT IS CRITICAL THAT THE WAVEFORM OF THE AC VOLTAGE IS NOT SIGNIFICANTLY NON-SINUSOIDAL OR OTHERWISE CORRUPTED BY SWITCHING CIRCUITS, ETC. CONNECT THE V/Ω AND COM TEST LEADS TO THE SAME AC VOLTAGE SOURCE (NOT AT THE SAME TIME AS THE OTHER METER IS CONNECTED). SET THE VOLTAGE RANGE APPROPRIATELY FOR THE TYPE OF AC SIGNAL BEING MEASURED (FOR EXAMPLE, 200V IF MEASURING 120VAC LINE VOLTAGE), AND THE FUNCTION SWITCH TO AC VOLTS (ACV). ROTATE THE "AC ADJ" TRIM POT 'R413' (LOCATED ON THE 'AC CONVERTER' CIRCUIT BOARD) FOR A READING THAT MATCHES THE VOLTAGE NUMBER WRITTEN DOWN AS DESCRIBED ABOVE.
12) THE ACmA CALIBRATION WAS DONE AT THE FACTORY USING A SELECTED RESISTOR R423, SO THERE IS NO ADJUSTMENT TO BE MADE AT THIS TIME. THERE IS NO ADJUSTMENT FOR DCmA.
13) THERE ARE TWO TRIM CAPACITORS ON THE 'AC CONVERTER' PCB, C403 "LOW CAL" AND C405 "HIGH CAL", AND THEY ARE IDENTIFIED BY SILK SCREENED LETTERING ON THE CIRCUIT BOARD. ADJUST BOTH OF THESE TRIM CAPS SO THAT THE SILVERED HALF OF EACH PLATE (SEMI-CIRCULAR SHAPE) IS POSITIONED AWAY FROM THE CIRCUIT BOARD SURFACE (AND THE NON-SILVERED SEMI-CIRCULAR HALF POSITIONED TOWARDS THE CIRCUIT BOARD SURFACE). SEE DETAIL DIAGRAM BELOW. THIS CENTERS THE CAPACITY OF EACH TRIM CAP WITHIN ITS RANGE. THIS SETTING IS ADEQUATE FOR MOST APPLICATIONS OF THE METER.



THE 1240 METER HAS THREE FUSES, EACH "AGX" SIZE (OR "8AG" TYPE), WHICH ARE 1/4" DIAMETER AND 1" LONG. THEIR FRONT PANEL SOCKETS MIGHT BE ABLE TO ACCEPT "3AG" FUSES, WHICH ARE 1/4" X 1-1/4", BUT THIS HAS NOT BEEN VERIFIED. THE FRONT PANEL FUSES MUST BE "FAST BLOW" TYPES (NOT "SLOW BLOW"), WHILE THE REAR PANEL FUSE, FOR INCOMING AC POWER, MUST BE A "SLOW BLOW" TYPE. ALL FUSES ARE ACCESSED FROM OUTSIDE THE METER'S CASE, UNSCREWING THEM FROM THEIR RECEPTACLES USING THE HEX DRIVER BUILT INTO ONE OF THE METER'S HANDLE KNOBS. IF THE HANDLE KNOBS ARE MISSING, USE A NORMAL HEX DRIVER (OR "ALLEN WRENCH") OF #12 SIZE (3/16").

NOTE THAT THE FRONT PANEL FUSES ARE BUILT INTO THE "VΩ" AND "mA" TEST LEAD JACKS, WHILE THE AC POWER FUSE ON THE REAR PANEL IS ACTUALLY PART OF THE AC LINE CORD SOCKET.

SPECIFICATIONS

DC VOLTS
- ACCURACY
  - 200mV RANGE: >100MΩ IMPEDANCE, +/-0.1% +/-1 DIGIT ACCURACY, 350V OVERLOAD PROTECT
  - 2V RANGE: >1000MΩ IMPEDANCE, +/-0.1% +/-1 DIGIT ACCURACY, 350V OVERLOAD PROTECT
  - 20V/200V/1000V RANGE: 10MΩ IMP., +/-0.1% +/-1 DIGIT ACCURACY, 1000V OVERLOAD PROTECT
- OVERRANGE CAPABILITY: 20% MINIMUM (SUBJECT TO OVERLOAD PROTECTION LIMITS)
- RESOLUTION (200mV RANGE): 100µV
- TEMPERATURE INFLUENCE: +/-0.005%/DEG C, +/-0.1 DIGIT/DEG C
- NORMAL MODE REJECTION: 35dB MINIMUM AT 60Hz
- COMMON MODE REJECTION: 80dB MINIMUM WITH 1k UNBALANCE AT 60Hz

AC VOLTS (AVERAGE RESPONDING, RMS CALIBRATED)
- OVERLOAD PROTECTION
  - 200mV RANGE: 1MΩ IMPEDANCE AT 150pF, 250V RMS OVERLOAD PROTECTION
  - 2V RANGE: 1MΩ IMPEDANCE AT 150pF, 250V OVERLOAD PROTECTION
  - 20V RANGE: 1MΩ IMPEDANCE AT 150pF, 500V OVERLOAD PROTECTION
  - 200V RANGE: 1MΩ IMPEDANCE AT 150pF, 500V OVERLOAD PROTECTION
  - 1000V RANGE: 1MΩ IMPEDANCE AT 150pF, 500V OVERLOAD PROTECTION
- ACCURACY
  - +/-0.5% +/- 1 DIGIT (40Hz~10kHz)
  - +/-1% +/- 1 DIGIT (10kHz~20kHz)
- RESOLUTION: 100µV
- TEMPERATURE INFLUENCE: +/-0.05%/DEG C, +/-0.1 DIGIT/DEG C 40Hz~10kHz
  +/-0.1%/DEG C, +/-0.2 DIGIT/DEG C 10kHz~20kHz

DC AMPS
- ACCURACY
  - 200µA RANGE: 0.2V VOLTAGE DROP, +/-0.25% +/-1 DIGIT
  - 2mA RANGE: 0.2V VOLTAGE DROP, +/-0.2% +/-1 DIGIT
  - 20mA RANGE: 0.2V VOLTAGE DROP, +/-0.2% +/-1 DIGIT
  - 200mA RANGE: 0.2V VOLTAGE DROP, +/-0.3% +/-1 DIGIT
  - 2A RANGE: 0.2V VOLTAGE DROP, +/-0.5% +/-1 DIGIT
- RESOLUTION: 100nA
- OVERLOAD PROTECTION: 3A, ANY RANGE, BY FUSE AND CLAMPING DIODES

AC AMPS (40Hz TO 10kHZ)
- ACCURACY
  - 200µA RANGE: 0.2V VOLTAGE DROP, +/-0.75% +/-1 DIGIT
  - 2mA RANGE: 0.2V VOLTAGE DROP, +/-0.7% +/-1 DIGIT
  - 20mA RANGE: 0.2V VOLTAGE DROP, +/-0.7% +/-1 DIGIT
  - 200mA RANGE: 0.2V VOLTAGE DROP, +/-0.8% +/-1 DIGIT
  - 2A RANGE: 0.2V VOLTAGE DROP, +/-1% +/-1 DIGIT
- RESOLUTION: 100nA
- OVERLOAD PROTECTION: 3A, ANY RANGE, BY FUSE AND CLAMPING DIODES

RESISTANCE
- ACCURACY
  - 200Ω RANGE: 1mA TEST CURRENT, +/-0.5% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION *
  - 2k RANGE: 100µA TEST CURRENT, +/-0.5% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION *
  - 20k RANGE: 10µA TEST CURRENT, +/-0.5% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION
  - 200k RANGE: 10µA TEST CURRENT, +/-0.5% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION
  - 2M RANGE: 1µA TEST CURRENT, +/-0.5% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION
  - 20M RANGE: 100nA TEST CURRENT, +/-1% +/-1 DIGIT, 250V RMS OVERLOAD PROTECTION

  * BY FUSE AND CLAMPING DIODES (THESE TWO RANGES BORROW THE PROTECTION OF THE AC AMPS CIRCUIT)

  TEMPERATURE INFLUENCE: +/- 0.05% READING/DEG C +/-0.1 DIGIT/DEG C
  OVERRANGE CAPACBILITY: 20% MINIMUM

GENERAL
- SIZE: 3"H x 7"W x 7.9"D
- WEIGHT: APPROX. 4 POUNDS
- DISPLAY:
  - MAXIMUM COUNT: 1999 (3-1/2 DIGITS)
  - OVERRANGE INDICATION: AUTOMATIC "OVER" BEYOND 1999
  - POLARITY INDICATION: AUTOMATIC "+" OR "-"
  - DISPLAY UPDATE RATE: 5 PER SECOND, NON-BLINKING
  - NUMERIC DISPLAY TYPE: SIDE-VIEWING NEON GLOW TUBES (NIXIE TYPE) WITH INTEGRAL DECIMAL POINTS
  - INPUT RANGE: MANUALLY SELECTED (NOT AUTO-RANGING)
- POWER REQUIREMENT:
  - VOLTAGE: 115VAC OR 230VAC (SET USING A SLIDE SWITCH ON THE REAR PANEL)
  - TOLERANCE: +15%, -10% OF RATED VOLTAGE
  - FREQUENCY: 50~400Hz
  - POWER DRAIN: 6W NOMINAL
- VOLTAGE ISOLATION:
  - METER CIRCUIT ISOLATED FROM EARTH/POWER LINE GROUND
  - METER MAY BE OPERATED 500V ABOVE POWER LINE GROUND POTENTIAL
- OPERATING TEMPERATURE: 10 DEG C TO 40 DEG C

THE METER'S ACCESSORY EDGE CONNECTOR, WHICH PROTRUDES FROM THE MAIN CIRCUIT BOARD VIA A SLOT IN THE REAR PANEL, HAS POTENTIALLY LETHAL VOLTAGES ON SOME OF ITS CONTACTS. IF THE BATTERY PACK ACCESSORY IS NOT ATTACHED TO THE METER, A COVER OR CAP SHOULD BE PLUGGED OVER THIS CONNECTOR FOR SAFETY.

IF THE METER'S INPUT LEADS ARE LEFT 'OPEN CIRCUITED' WHILE ON THE 200mV OR 2V RANGES (WHILE THE METER IS SELECTED TO THE AC OR DC VOLTS FUNCTIONS), THE DISPLAY READING WILL SLOWLY INCREASE DUE TO THE PRESENCE OF A SMALL CURRENT APPEARING ACROSS THE HIGH IMPEDANCE OF THE A/D CONVERTER. ON THE 20V, 200V AND 1000V RANGES, THE READING WILL REMAIN AT ZERO. A SIMILAR EFFECT OCCURS ON ANY RANGE IF ALL FOUR OF THE FUNCTION PUSHBUTTONS ARE UP (DISENGAGED).

BASIC CIRCUIT OPERATION

THE 1240 METER CAN MEASURE AC AND DC VOLTS, AC AND DC CURRENT (mA), AND RESISTANCE (OHMS). ALL OF THE INPUTS ARE SCALED AND/OR CONVERTED TO BASIC MEASURING RANGES OF 0~200mV OR 0~2V, DEPENDING ON THE RANGE SWITCH SETTING. THESE BASIC PRE-SCALED SIGNALS ARE MEASURED BY A HIGH IMPEDANCE BIPOLAR A/D (ANALOG TO DIGITAL) CONVERTER WHICH OPERATES ON THE DUAL-SLOPE PRINCIPLE, WHICH HAS THE ADVANTAGE IS REJECTING MOST ERRORS DUE TO INSTABILITY OF THE ELECTRONIC COMPONENTS USED IN THE CONVERTER, INCLUDING THOSE INACCURACIES RESULTING FROM TEMPERATURE CHANGES.

THE DUAL-SLOPE ACTION OPERATES WITHIN A CYCLE WHICH REPEATS EVERY 200mS (FIVE TIMES EVERY SECOND). EACH CYCLE IS ARRANGED TO OCCUR WITHIN 8000 PULSES OF A 40kHZ CLOCK OSCILLATOR, AND EACH CYCLE IS DIVIDED INTO TWO TIME ELEMENTS, t1 AND t2. DURING TIME ELEMENT t1, AN INTEGRATOR CIRCUIT CAUSES A VOLTAGE TO "RAMP UP", CHARGING A CAPACITOR. DURING TIME ELEMENT t2, THE INTEGRATOR DISCHARGES "RAMP DOWN"; THE TIME REQUIRED TO DISCHARGE THE CAPACITOR IS COUNTED, DECODED AND DISPLAYED WITH A READING PROPORTIONAL TO THE VALUE BEING MEASURED. THE INTEGRATOR IS CONFIGURED TO EXPECT AN INPUT OF EITHER 0~200mV OR 0~2V, DEPENDING ON THE RANGE SELECTION, AND THIS CORRESPONDS TO HOW THE METER'S FRONT END CIRCUITRY PRE-SCALES THE INPUTS. THE SCALED INPUT SIGNAL VOLTAGE TO THE INTEGRATOR AFFECTS THE RATE OF THE RAMP'S SLOPE, AND THUS ITS PEAK VOLTAGE. BECAUSE THE INTEGRATOR IS 'BIPOLAR', ITS RAMP VOLTAGES CAN ALSO BE NEGATIVE (LESS THAN 0V), SUCH THAT THE "RAMP UP" VOLTAGE ACTUALLY DECREASES, AND THE "RAMP DOWN" VOLTAGE INCREASES; THIS IS DETECTED BY LOGIC CIRCUITS WHICH CONTROL OPERATION OF THE INTEGRATOR CHARGE AND DISCHARGE, AND ALSO CONTROL THE DISPLAY OF "+" AND "-" POLARITY INDICATIONS ON THE DC VOLTS AND DC mA FUNCTIONS.

DC VOLTAGES ARE CONDITIONED BY VARIOUS DEGREES OF ATTENUATION, EXCEPT FOR THE 200mV AND 2V RANGES, WHICH ARE ALREADY WITHIN THE NATIVE RANGES OF THE A/D CONVERTER. AC VOLTAGES USE A DIFFERENT ATTENUATOR FROM THE ONE USED FOR DC VOLTAGE, AND THIS IS FOLLOWED BY A PRECISION RECTIFIER OP-AMP CIRCUIT WHICH CONVERTS THE AC SIGNAL INTO A DC ONE CORRESPONDING TO THE AVERAGE RMS VALUE OF THE SINUSOIDAL AC INPUT SIGNAL. DC CURRENTS ARE PASSED THROUGH A PRECISION SHUNT RESISTANCE, AND THE DC VOLTAGE DROPPED ACROSS THE SHUNT IS PROPORTIONAL TO THE CURRENT, AND IS THEN MEASURED JUST LIKE DC VOLTAGE. AC CURRENTS ARE PASSED THROUGH THE SAME SHUNT AS WITH DC CURRENT, AND THE DROPPED VOLTAGE IS RECTIFIED BY THE SAME PRECISION RECTIFIER AS WITH AC VOLTS. RESISTANCE IS MEASURED BY PASSING AN INTERNALLY GENERATED PRECISION CONSTANT CURRENT THROUGH THE RESISTANCE UNDER TEST, AND THE DROPPED VOLTAGE ACROSS THAT RESISTANCE IS PROPORTIONAL TO THE RESISTANCE, AND IS THEN MEASURED IN THE SAME WAY AS DC VOLTAGE.

THE DIGITAL LOGIC SECTION OF THE METER CIRCUIT FOLLOWS THE ANALOG SECTION DESCRIBED ABOVE, AND IT ALSO REACHES BACK TO CONTROL THE A/D CONVERTER'S INTEGRATOR ACCORDING TO WHICH PART OF THE TIMED CYCLE THE CIRCUIT IS IN, AND WHETHER POSITIVE OR NEGATIVE VOLTAGES OR CURRENTS ARE BEING INPUT. THE LOGIC ALSO HANDLES THE COUNTING OF THE PULSES WITHIN EACH CYCLE, AND DISPLAYS THE PORTION OF THE CYCLE COUNT WHICH IS PROPORTIONAL TO THE MEASURED VALUE, AND THEN CONDITIONS THAT COUNTED VALUE FOR DISPLAY. THE LOGIC DETECTS OVERRANGE CONDITIONS ACCORDING TO BOTH THE LOGICAL COUNT AS WELL AS THE ACTUAL INTEGRATOR OUTPUT VOLTAGE, AND CONTROLS THE "OVER" RANGE INDICATOR. FINALLY, THE LOGIC DETECTS + AND - POLARITIES AND CONTROLS THE APPROPRIATE POLARITY INDICATORS.

ALL DIGITAL LOGIC IS COMPRISED OF THE OLD STYLE 'RTL' (RESISTOR TRANSISTOR LOGIC) INTEGRATED CIRCUITS (ICs), WHICH USE ONLY 3.5VDC FOR POWER AND THEIR 'HIGH' LOGIC LEVELS.

SOME OPERATIONAL DETAILS

1) ALLOW THE METER A 15 MINUTE WARM-UP TO INSURE BEST ACCURACY.
2) ALL CIRCUITS ARE PROTECTED AGAINST OVERLOADS, EITHER THROUGH RESISTOR-DIODE NETWORKS, OR THROUGH TRANSISTOR CLAMPING, AND/OR THROUGH FUSES LOCATED INSIDE THE CHASSIS.
3) IT IS NORMAL FOR THE RIGHT HAND (LEAST SIGNIFICANT) DIGIT OF THE DISPLAY TO ALTERNATE ONE NUMBER ON SUCCESSIVE COUNTS.
4) "DO NOT EXCEED" INPUT VALUES ARE SHOWN IN A CHART ON THE REAR OF THE METER.
5) THE DISPLAY'S "OVER" RANGE INDICATOR WILL FLICKER WHEN THE INPUT SIGNAL IS HIGHER THAN THE SETTING OF THE RANGE SWITCH, BUT WILL REMAIN ON STEADILY WHEN THE INPUT REACHES A MORE EXTREME OVERLOAD CONDITION.
6) ONE OR THE OTHER OF THE "+" AND "-" INDICATORS WILL ALWAYS ILLUMINATE WHILE MEASURING DC VOLTS OR DCmA OR OHMS, EVEN THOUGH SUCH INDICATIONS ARE NOT APPLICABLE IN OHMS MEASUREMENTS.
7) THE PROPER DECIMAL POINT LOCATION IS DETERMINED AUTOMATICALLY BY THE RANGE SWITCH.
8) THE DISPLAY CAN SHOW VALUES AS LOW AS 0 AND AS HIGH AS 1999. THE METER DESIGN ALLOWS UP TO A 20% OVER-RANGE ON ALL RANGES EXCEPT FOR 1000 (SEE NOTE 9 BELOW). DO NOT 'FLOAT' THE METER'S 'COM' INPUT MORE THAN 500V ABOVE THE POWER LINE GROUND, AS THIS CAN RESULT IN DAMAGE TO THE INSTRUMENT.
9) WHEN THE DISPLAY READS "OVER" (FLICKERING) AND THE NUMERICAL DISPLAY IS 000 (IRRESPECTIVE OF DECIMAL POINT POSITION), THIS MEANS A READING OF EXACTLY 2000 (ONE DIGIT HIGHER THAN 1999). EXCEPT FOR THE 1000 RANGE, IT IS POSSIBLE TO THEN EXCEED THE VIRTUAL 2000 COUNT, UP TO 20%. FOR EXAMPLE, IF THE METER IS IN THE 20V RANGE AND A 24 VOLT SIGNAL IS INPUT, THE DISPLAY WILL SHOW "OVER 4", AND THE USER CAN ASSUME THE VIRTUAL 20 PART AND 'READ' A VALUE OF 24. OVERRANGE READINGS HIGHER THAN 20% ARE UNRELIABLE.

THE WESTON 1240 IS VERY WELL DESIGNED AND THOUGHT-OUT, EXCEPT FOR WHEN IT IS NECESSARY TO TROUBLESHOOT A PROBLEM WHEN THE METER IS ANYWHERE ELSE BESIDES THE FACTORY. THIS IS BECAUSE ALL METER FUNCTIONALITY DEPENDS ON THE FUNCTION SWITCH CONTACTS BEING MADE IN ONE OF THE VALID COMBINATIONS, YET WITH THE CIRCUIT BOARD REMOVED FROM THE CASE FOR SERVICING, THE BEZEL MUST BE REMOVED, DIVORCING THE FUNCTION SWITCH CONTACTS FROM THE CIRCUIT BOARD. NO DOUBT THE FACTORY HAD SOME TEST RIG TO DEAL WITH THIS, BUT FOR ANYONE ELSE TRYING TO REPAIR A 1240, IT CAN BE A TRYING EXPERIENCE.

THAT SAID, IN THE EXPERIENCE OF THE AUTHOR OF THESE DOCUMENTS, AFTER RESTORING A FEW 1240'S, THE PROBLEM WAS ALMOST ALWAYS WITH THE POWER SUPPLY, AND AT LEAST THIS PORTION OF THE CIRCUIT DOES NOT DEPEND ON THE FUNCTION SWITCH WORKING. TYPICALLY, THE OP-AMPS, THE RTL LOGIC IC's, AND THE NON-POWER SUPPLY TRANSISTORS ON A 1240 SEEM TO BE VERY ROBUST AND UNLIKELY TO FAIL.

ANALOG & DIGITAL CIRCUITRY IS SHOWN ON SHEETS 1&2 OF THIS DRAWING

NOTES AND OTHER INFORMATION ARE LOCATED ON SHEET 3 OF THIS DRAWING

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE WESTON/SCHLUMBERGER 1240. 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.

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WESTON/SCHUMBERGER 1240 DIGITAL MULTIMETER SCHEMATIC DIAGRAM