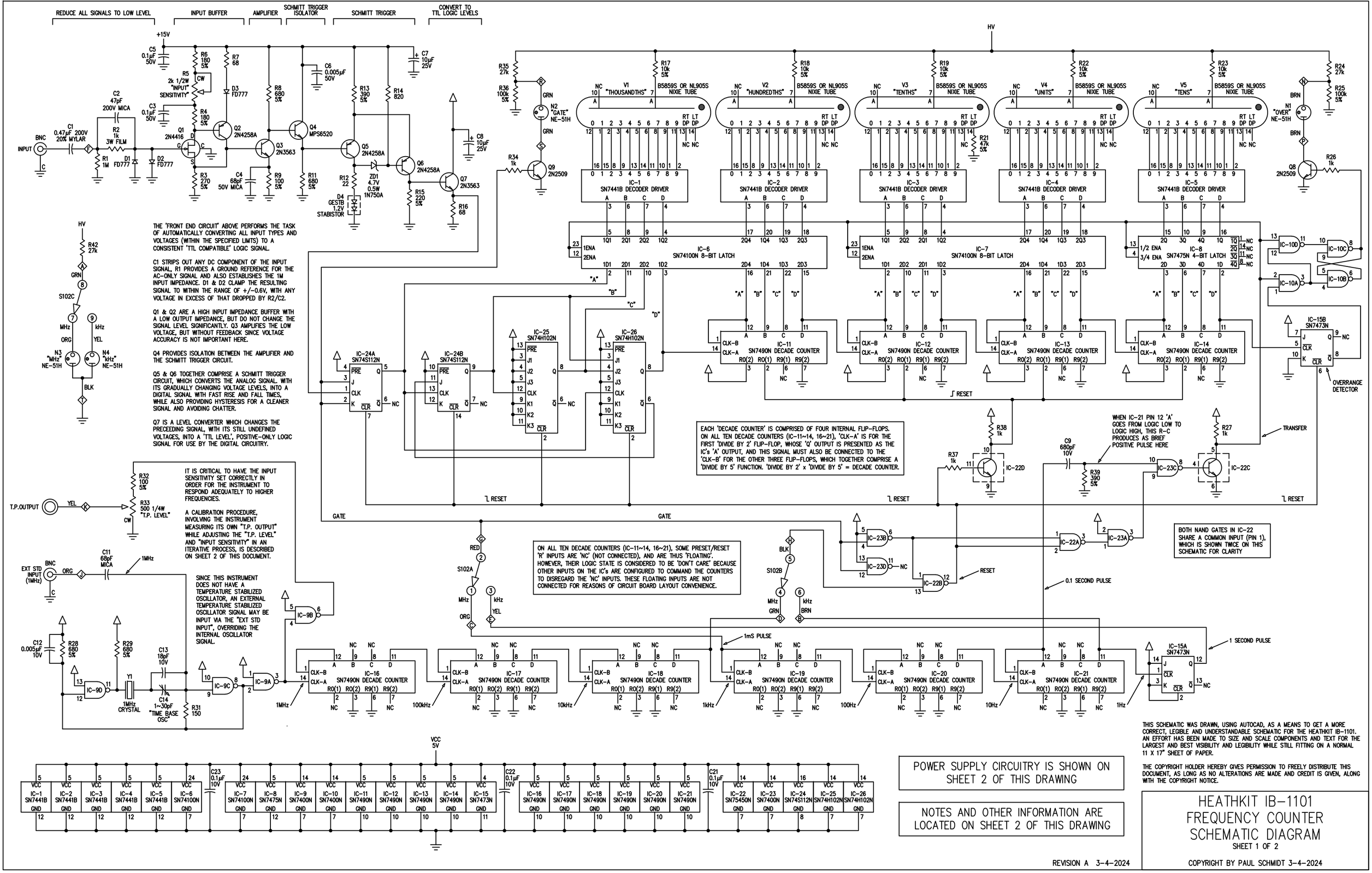

REDUCE ALL SIGNALS TO LOW LEVEL
INPUT BUFFER
AMPLIFIER
SCHMITT TRIGGER ISOLATOR
SCHMITT TRIGGER
CONVERT TO TTL LOGIC LEVELS
+15V
HV
BNC INPUT
C1 0.47µF 200V 20% MYLAR
C2 47pF 200V MICA
R1 1M
R2 1k 3W FILM
D1 FD777
D2 FD777
R3 270 5%
C3 0.1µF 50V
R4 180 5%
R5 2k 1/2W "INPUT" SENSITIVITY
CW
R6 180 5%
R7 68
D3 FD777
Q1 2N4416
Q2 2N4258A
R8 680 5%
Q3 2N3563
C4 68pF 50V MICA
R9 100 5%
C6 0.005µF 50V
Q4 MPS6520
R11 680 5%
R12 22
R13 390 5%
R14 820
Q5 2N4258A
ZD1 4.7V 0.5W 1N750A
D4 GESTB 1.2V STABISTOR
Q6 2N4258A
R15 220 5%
C7 10µF 25V
Q7 2N3563
R16 68
C8 10µF 25V
R35 27k
R36 100k 5%
R34 1k
N2 "GATE" NE-51H
Q9 2N2509
R17 10k 5%
R18 10k 5%
R19 10k 5%
R21 47k 5%
R22 10k 5%
R23 10k 5%
R24 27k
R25 100k 5%
N1 "OVER" NE-51H
Q8 2N2509
R26 1k
V1 "THOUSANDTHS"
V2 "HUNDREDTHS"
V3 "TENTHS"
V4 "UNITS"
V5 "TENS"
B5859S OR NL905S NIXIE TUBE
RT LT DP DP
NC NC
IC-1 SN7441B DECODER DRIVER
IC-2 SN7441B DECODER DRIVER
IC-3 SN7441B DECODER DRIVER
IC-4 SN7441B DECODER DRIVER
IC-5 SN7441B DECODER DRIVER
IC-6 SN74100N 8-BIT LATCH
IC-7 SN74100N 8-BIT LATCH
IC-8 SN7475N 4-BIT LATCH
1/2 ENA
3/4 ENA
IC-10D
IC-10C
IC-10A
IC-10B
IC-15B SN7473N
OVERRANGE DETECTOR
"A"
"B"
"C"
"D"
IC-11 SN7490N DECADE COUNTER
IC-12 SN7490N DECADE COUNTER
IC-13 SN7490N DECADE COUNTER
IC-14 SN7490N DECADE COUNTER
RESET
IC-24A SN74S112N
IC-24B SN74S112N
IC-25 SN74H102N
IC-26 SN74H102N
R38 1k
R37 1k
IC-22D
C9 680pF 10V
R39 390 5%
IC-23C
IC-22C
R27 1k
TRANSFER
WHEN IC-21 PIN 12 'A' GOES FROM LOGIC LOW TO LOGIC HIGH, THIS R-C PRODUCES AS BRIEF POSITIVE PULSE HERE
EACH 'DECADE COUNTER' IS COMPRISED OF FOUR INTERNAL FLIP-FLOPS. ON ALL TEN DECADE COUNTERS (IC-11~14, 16~21), 'CLK-A' IS FOR THE FIRST 'DIVIDE BY 2' FLIP-FLOP, WHOSE 'Q' OUTPUT IS PRESENTED AS THE IC's 'A' OUTPUT, AND THIS SIGNAL MUST ALSO BE CONNECTED TO THE 'CLK-B' FOR THE OTHER THREE FLIP-FLOPS, WHICH TOGETHER COMPRISE A 'DIVIDE BY 5' FUNCTION. 'DIVIDE BY 2' x 'DIVIDE BY 5' = DECADE COUNTER.
ON ALL TEN DECADE COUNTERS (IC-11~14, 16~21), SOME PRESET/RESET 'R' INPUTS ARE 'NC' (NOT CONNECTED), AND ARE THUS 'FLOATING'. HOWEVER, THEIR LOGIC STATE IS CONSIDERED TO BE 'DON'T CARE' BECAUSE OTHER INPUTS ON THE IC's ARE CONFIGURED TO COMMAND THE COUNTERS TO DISREGARD THE 'NC' INPUTS. THESE FLOATING INPUTS ARE NOT CONNECTED FOR REASONS OF CIRCUIT BOARD LAYOUT CONVENIENCE.
BOTH NAND GATES IN IC-22 SHARE A COMMON INPUT (PIN 1), WHICH IS SHOWN TWICE ON THIS SCHEMATIC FOR CLARITY
THE 'FRONT END CIRCUIT' ABOVE PERFORMS THE TASK OF AUTOMATICALLY CONVERTING ALL INPUT TYPES AND VOLTAGES (WITHIN THE SPECIFIED LIMTS) TO A CONSISTENT 'TTL COMPATIBLE' LOGIC SIGNAL.
C1 STRIPS OUT ANY DC COMPONENT OF THE INPUT SIGNAL, R1 PROVIDES A GROUND REFERENCE FOR THE AC-ONLY SIGNAL AND ALSO ESTABLISHES THE 1M INPUT IMPEDANCE. D1 & D2 CLAMP THE RESULTING SIGNAL TO WITHIN THE RANGE OF +/-0.6V, WITH ANY VOLTAGE IN EXCESS OF THAT DROPPED BY R2/C2.
Q1 & Q2 ARE A HIGH INPUT IMPEDANCE BUFFER WITH A LOW OUTPUT IMPEDANCE, BUT DO NOT CHANGE THE SIGNAL LEVEL SIGNIFICANTLY. Q3 AMPLIFIES THE LOW VOLTAGE, BUT WITHOUT FEEDBACK SINCE VOLTAGE ACCURACY IS NOT IMPORTANT HERE.
Q4 PROVIDES ISOLATION BETWEEN THE AMPLIFIER AND THE SCHMITT TRIGGER CIRCUIT.
Q5 & Q6 TOGETHER COMPRISE A SCHMITT TRIGGER CIRCUIT, WHICH CONVERTS THE ANALOG SIGNAL. WITH ITS GRADUALLY CHANGING VOLTAGE LEVELS, INTO A DIGITAL SIGNAL WITH FAST RISE AND FALL TIMES, WHILE ALSO PROVIDING HYSTERESIS FOR A CLEANER SIGNAL AND AVOIDING CHATTER.
Q7 IS A LEVEL CONVERTER WHICH CHANGES THE PRECEEDING SIGNAL, WITH ITS STILL UNDEFINED VOLTAGES, INTO A 'TTL LEVEL', POSITIVE-ONLY LOGIC SIGNAL FOR USE BY THE DIGITAL CIRCUITRY.
R42 27k
S102C
MHz
kHz
ORG
YEL
N3 "MHz" NE-51H
N4 "kHz" NE-51H
BLK
IT IS CRITICAL TO HAVE THE INPUT SENSITIVITY SET CORRECTLY IN ORDER FOR THE INSTRUMENT TO RESPOND ADEQUATELY TO HIGHER FREQUENCIES.
A CALIBRATION PROCEDURE, INVOLVING THE INSTRUMENT MEASURING ITS OWN "T.P. OUTPUT" WHILE ADJUSTING THE "T.P. LEVEL" AND "INPUT SENSITIVITY" IN AN ITERATIVE PROCESS, IS DESCRIBED ON SHEET 2 OF THIS DOCUMENT.
T.P.OUTPUT
R32 100 5%
R33 500 1/4W "T.P. LEVEL"
SINCE THIS INSTRUMENT DOES NOT HAVE A TEMPERATURE STABILIZED OSCILLATOR, AN EXTERNAL TEMPERATURE STABILIZED OSCILLATOR SIGNAL MAY BE INPUT VIA THE "EXT STD INPUT", OVERRIDING THE INTERNAL OSCILLATOR SIGNAL.
EXT STD INPUT (1MHz)
C11 68pF MICA
C12 0.005µF 10V
R28 680 5%
R29 680 5%
C13 18pF 10V
Y1 1MHz CRYSTAL
C14 1-30pF "TIME BASE OSC"
R31 150
IC-9D
IC-9C
IC-9A
IC-9B
1MHz
100kHz
10kHz
1kHz
100Hz
10Hz
1Hz
1mS PULSE
0.1 SECOND PULSE
1 SECOND PULSE
GATE
RED
S102A
S102B
VCC 5V
C23 0.1µF 10V
C22 0.1µF 10V
C21 0.1µF 10V
IC-1 SN7441B
IC-2 SN7441B
IC-3 SN7441B
IC-4 SN7441B
IC-5 SN7441B
IC-6 SN74100N
IC-7 SN74100N
IC-8 SN7475N
IC-9 SN7400N
IC-10 SN7400N
IC-11 SN7490N
IC-12 SN7490N
IC-13 SN7490N
IC-14 SN7490N
IC-15 SN7473N
IC-16 SN7490N
IC-17 SN7490N
IC-18 SN7490N
IC-19 SN7490N
IC-20 SN7490N
IC-21 SN7490N
IC-22 SN75450N
IC-23 SN7400N
IC-24 SN74S112N
IC-25 SN74H102N
IC-26 SN74H102N
GND
POWER SUPPLY CIRCUITRY IS SHOWN ON SHEET 2 OF THIS DRAWING
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 CORRECT, LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IB-1101. 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.
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.
HEATHKIT IB-1101
FREQUENCY COUNTER
SCHEMATIC DIAGRAM
SHEET 1 OF 2
REVISION A 3-4-2024
COPYRIGHT BY PAUL SCHMIDT 3-4-2024

GENERAL NOTES (APPLICABLE TO ALL SHEETS OF THIS DRAWING)

1) RESISTORS ARE CARBON COMPOSITE (CC), 1/4W, 10% 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. ON TRIM POTENTIOMETERS (TRIM POTS), THEIR PCB CONNECTIONS HAVE BEEN INSPECTED ON AN ACTUAL IB–1101 AND THIS NEW SCHEMATIC CONFORMS TO THE PHYSICAL REALITY IN REGARD TO CLOCKWISE 'CW' WIPER ROTATION. "T.P. LEVEL" TRIM POT 'R33' IS A SINGLE–TURN 1/4W TYPE WHILE "INPUT SENSITIVITY" TRIM POT 'R5' IS A 10–TURN 1/2W TYPE. RESISTOR IDENTIFIERS R10, R20, R30, R41 AND R41 ARE NOT USED.
2) HEATHKIT DID NOT SPECIFY MOST CAPACITOR VOLTAGES IN THE MANUAL OR REPLACEMENT PARTS LIST, AND STUDY OF A WORKING IB–1101 COUNTER REVEALED THAT SOME CAPACITORS WERE NOT PHYSICALLY MARKED WITH THEIR VOLTAGE. WHERE CAPACITOR VOLTAGES ARE NOT SHOWN ON THIS SCHEMATIC, THEY ARE NOT MARKED ON THE PHYSICAL COMPONENT AND/OR OTHER SOURCES OF INFORMATION. CAPACITORS ARE CERAMIC DISK TYPE UNLESS INDICATED OTHERWISE. CAPACITORS SHOWN AS POLARIZED (WITH +) ARE ALUMINUM ELECTROLYTIC TYPE. CAPACITOR IDENTIFIERS C10 AND C20 ARE NOT USED.
3) THERE ARE ONLY TWO SWITCHES, THE "RANGE" SWITCH 'S102' (WHICH IS SO INDICATED ON THE HEATHKIT SCHEMATIC DIAGRAM BUT NOT SO MARKED ON THE ACTUAL COUNTER) AND THE "POWER" SWITCH 'S101' (WHICH IS NOT DIRECTLY CALLED BY THAT NAME ANYWHERE). THIS SCHEMATIC DOES NOT USE EITHER TERM BECAUSE THE FUNCTIONALITY IS SELF–EVIDENT. THE "RANGE" SWITCH HAS THREE GANGS, 'S102A', 'S102B', AND 'S102C', AND THIS SCHEMATIC DOES NOT SHOW THE IMPLIED MECHANICAL COUPLING BETWEEN THEM.
4) DIGITAL IC'S HAVING MULTIPLE SECTIONS OR GATES (FLIP–FLOPS, 'AND' GATES) ARE DENOTED HEREIN WITH LETTER SUFFIXES, A, B, C, D; ACCORDING TO THE ORIGINAL HEATH SCHEMATIC. THESE SUFFIXES ARE ARBITRARY AND INCONSISTENTLY APPLIED, BUT ARE FAITHFULLY REPLICATED ON THIS DOCUMENT.
5) A SQUARE DIAMOND SYMBOL WITH A SINGLE LETTER, e.g. ◇A REPRESENTS POINTS ON THE CIRCUIT BOARD WHERE WIRES FROM CHASSIS–MOUNTED COMPONENTS ARE CONNECTED. THE LETTERING MATCHES THE HEATHKIT DOCUMENTATION AND MARKINGS ON THE ACTUAL CIRCUIT BOARD.
6) WHERE WIRE COLORS ARE SHOWN, THEY MATCH THE HEATHKIT DOCUMENTATION AND THE PHYSICAL IB–1101 INSPECTED IN PREPARATION FOR MAKING THIS DOCUMENT.
7) POWER SUPPLY PINS ON THE IC'S HAVE HEREIN BEEN SHOWN GROUPED TOGETHER NEAR THE BOTTOM OF SHEET 1, RATHER THAN HAVE THEM CLUTTERING UP THE REST OF THE FUNCTIONAL SCHEMATIC.
8) THE ORIGINAL HEATHKIT SCHEMATIC HAD MANY ERRORS, ESPECIALLY IN REGARD TO IC 'PINOUTS', AND IN REGARD TO OMISSIONS WHERE THE HEATHKIT DRAFTSMAN APPARENTLY THOUGHT THERE WAS NO NEED TO SHOW PINS THAT WERE NOT USED, BUT THIS EXTENDED TO OMITTING PINS THAT ARE ACTUALLY USED. THIS NEW SCHEMATIC CORRECTS THESE ISSUES, BASED ON CAREFUL STUDY OF AN ACTUAL IB–1101 CIRCUIT BOARD AND THE HEATHKIT MANUAL'S "CIRCUIT BOARD X–RAY VIEW".
9) THE HEATHKIT SCHEMATIC USED MANY IC PIN DESCRIPTIONS WHICH ARE INCONSISTENT WITH THE IC MANUFACTURER'S DOCUMENTATION, AND WHICH ARE SOMETIMES CONFUSING. THIS NEW SCHEMATIC RESTORES THE IC PIN DESCRIPTIONS ACCORDING TO ORIGINAL TEXAS INSTRUMENT IC DATASHEETS.

SIMPLIFIED CALIBRATION PROCEDURE

1) THE FOLLOWING PROCEDURE ASSUMES THAT SOME LABORATORY INSTRUMENTS (AS DESCRIBED) ARE AVAILABLE; THE ORIGINAL HEATHKIT MANUAL'S PROCEDURE FOR CALIBRATION USING A BROADCAST RECEIVER OR AN AM RADIO ARE NOT INCLUDED HERE.
2) BEFORE BEGINNING THE CALIBRATION PROCEDURE, TURN THE COUNTER ON AND ALLOW IT TO WARM UP FOR AT LEAST 30 MINUTES.
3) CLOCK CALIBRATION USING ACCURATE FUNCTION GENERATOR:THE COUNTER'S "T.P. LEVEL" CONTROL (ACCESSED THROUGH A HOLE IN THE REAR PANEL) IS NOT USED FOR THIS PROCEDURE. FOR THE FOLLOWING STEPS, THE SIGNAL GENERATOR MAY EITHER BE A MODERN TYPE WITH DIGITAL FREQUENCY DISPLAY AND RELIABLE ACCURACY, OR IT MAY BE A LESS ACCURATE GENERATOR IN CONJUNCTION WITH ANOTHER FREQUENCY COUNTER TO MEASURE THE GENERATOR'S OUTPUT FREQUENCY. CONNECT A BNC–TO–BNC SHIELDED CABLE BETWEEN THE OUTPUT OF THE FUNCTION GENERATOR AND THE COUNTER'S FRONT "INPUT" JACK. SET THE COUNTER'S RANGE SWITCH TO THE "MHz" POSITION. ON THE GENERATOR, SELECT A FREQUENCY BETWEEN 10MHz AND 99MHz, AND SET THE OUTPUT AMPLITUDE FOR APPROXIMATELY 0.25V RMS (250mV). IF THE COUNTER DOES NOT INDICATE THE GENERATOR'S FREQUENCY, USE A METAL BLADED CALIBRATION TOOL WITH A NON–CONDUCTIVE HANDLE TO ADJUST THE COUNTER'S "INPUT SENSITIVITY" CONTROL (ACCESSED THROUGH HOLE IN REAR PANEL) UNTIL THE CORRECT FREQUENCY IS DISPLAYED. REDUCE THE SIGNAL GENERATOR OUTPUT VOLTAGE UNTIL THE COUNTER'S DISPLAY BECOMES UNSTABLE OR GOES TO ZERO (0). SLOWLY READJUST THE "INPUT SENSITIVITY" TO AGAIN OBTAIN A CORRECT DISPLAY. REPEAT THE STEPS OF REDUCING GENERATOR OUTPUT AND READJUSTING "INPUT SENSITIVITY" UNTIL YOU REACH THE SMALLEST GENERATOR OUTPUT VOLTAGE THAT STILL PRODUCES A CORRECT DISPLAY. SET THE GENERATOR OUTPUT AGAIN TO 250mV. USE THE METAL BLADED CALIBRATION TOOL TO ADJUST THE "TIME BASE OSC" CONTROL (ACCESSED THROUGH HOLE IN REAR PANEL) UNTIL THE COUNTER DISPLAY EXACTLY MATCHES THE GENERATOR'S OUTPUT FREQUENCY, +/– ONE LEAST–SIGNIFICANT DIGIT.
4) REPEAT THE STEPS FOR ADJUSTING THE "INPUT SENSITIVITY" TO MAKE SURE THAT THE COUNTER STILL RESPONDS CORRECTLY TO THE HIGHEST AVAILABLE GENERATOR FREQUENCY (OF LESS THAN 100MHz).
5) THIS ENDS THE 'CLOCK CALIBRATION USING ACCURATE FUNCTION GENERATOR' PROCEDURE.
6) HERE BEGINS A SEPARATE PROCEDURE FOR ADJUSTING THE "INPUT SENSITIVITY" IF THE COUNTER'S CLOCK OSCILLATOR (THE 'CLOCK') IS ALREADY CALIBRATED SATISFACTORILY BUT IT IS NOTICED THAT THE COUNTER IS NOT RESPONDING TO HIGHER FREQUENCIES:THE TWO ADJUSTMENTS ARE BOTH ACCESSED THROUGH HOLES IN REAR PANEL AND SHOULD BE ADJUSTED USING A METAL BLADED CALIBRATION TOOL. TURN THE "T.P. LEVEL" CONTROL FULLY COUNTERCLOCKWISE. USE A BNC–TO–TEST LEADS TYPE CABLE, CONNECTING THE BNC PLUG ONTO THE "INPUT" JACK ON THE FRONT PANEL; LEAVE THE BLACK (–) TEST LEAD UNCONNECTED, AND CLIP THE RED (+) TEST LEAD TO THE "T.P. OUTPUT" PIN ON THE REAR PANEL (THE COUNTER WILL BE MEASURING ITS OWN CLOCK OSCILLATOR, BUT THE EXACT FREQUENCY IS NOT CRITICAL FOR THIS PROCEDURE). SET THE "RANGE" SWITCH TO "MHz". IF A COUNTER READING OF 01.000 (1MHz) IS NOT PRESENT, USE THE CALIBRATION TOOL TO ADJUST THE "INPUT SENSITIVITY" CONTROL UNTIL THIS DESIRED READING APPEARS. TURN THE "T.P. LEVEL" CONTROL VERY SLOWLY CLOCKWISE UNTIL THE 1MHz READING JUST DISAPPEARS OR CHANGES TO A LOWER NUMBER. READJUST THE "INPUT SENSITIVITY" CONTROL VERY SLOWLY (PROBABLY COUNTERCLOCKWISE) UNTIL THE 1MHz READING IS AGAIN OBTAINED. REPEAT THE LAST TWO STEPS (TURNING THE "T.P. LEVEL" CONTROL CLOCKWISE UNTIL THE DISPLAY CHANGES FOR THE WORSE, FOLLOWED BY ADJUSTING THE "INPUT SENSITIVITY" CONTROL IN THE SAME DIRECTION AS BEFORE UNTIL THE CORRECT 1MHz READING REAPPEARS) MORE TIMES UNTIL THE "T.P. LEVEL" CONTROL HAS BEEN TURNED CLOCKWISE AS FAR AS POSSIBLE WHILE STILL BEING ABLE TO OBTAIN THE 1MHz READING AFTER ADJUSTMENT OF THE "INPUT SENSITIVITY" CONTROL.

BASIC COUNTER OPERATION

THE IB–1101 FREQUENCY COUNTER CAN MEASURE A WIDE RANGE OF INPUT SIGNALS OF VARIOUS KINDS, OVER A WIDE FREQUENCY RANGE, WITH ONLY ONE OPERATOR CONTROL; ALL ELSE IS AUTOMATIC.

CAUTION: IF CHECKING AC LINE VOLTAGE, DO NOT CONNECT THE GROUND LEAD OF ANY TEST CABLE (PLUGGED INTO THE COUNTER'S BNC "INPUT" JACK) TO EITHER SIDE (HOT OR NEUTRAL) OF THE AC LINE VOLTAGE OR CONNECTED CIRCUITS. FOR ALL AC LINE FREQUENCY TESTS, USE ONLY THE TEST LEAD THAT IS CONNECTED TO THE CENTER PIN OF THE BNC "INPUT" JACK; THE COUNTER WILL STILL RESPOND TO THE SIGNAL.

THE TIME BASE SWITCH (MHz & kHz) IS THE ONLY OPERATOR CONTROL. SELECTING THE "kHz" POSITION RESULTS IN THE COUNTER USING A "GATE" PERIOD OF 1 SECOND, AND WHILE SELECTING THE "MHz" POSITION RESULTS IN THE COUNTER USING A "GATE" PERIOD OF 1mS (ONE THOUSANDTH OF A SECOND). THE COUNTER SIMPLY DISPLAYS HOW MANY PULSES OR AC CYCLES ARE PRESENT AT THE "INPUT" JACK DURING EACH "GATE" PERIOD. THE "GATE" INDICATOR ON THE FRONT PANEL, TO THE LEFT OF THE NUMERICAL READOUT, WILL BE ILLUMINATED DURING THE "GATE" PERIOD, WHICH IN THE MHz RANGE/MODE WILL BE SO RAPID AS TO APPEAR CONSTANTLY ILLUMINATED.

ANY STANDARD 10 MΩ OSCILLOSCOPE PROBE CAN BE USED WITH THIS COUNTER. THE COUNTER WILL ALSO WORK WITH ANY BNC TYPE CABLE, INCLUDING THOSE CABLE WITH SIMPLE TEST CLIPS AT THE OTHER END. HOWEVER, SIMPLE TEST CABLES SHOULD BE USED WITH CAUTION WHEN TESTING TRANSMISSION LINES, DUE TO REFLECTION ISSUES.

NOTE THAT THE MAXIMUM INPUT VOLTAGE IS DERATED AS THE FREQUENCY INCREASES (SEE THE SPECIFICATIONS). THE MAXIMUM INPUT VOLTAGE IS 250VDC, MAXIMUM 140VAC RMS AT LOW FREQUENCIES, GRADUALLY DROPPING TO ONLY 3V RMS AT 100MHz.

IF THE INPUT FREQUENCY IS CHANGED, OR CHANGES, DURING THE TIME BETWEEN "GATE" PERIODS (WHEN THE "GATE" INDICATOR IS OFF), THE COUNTER WILL SHOW AN INCORRECT READING UNTIL THE NEXT GATE PERIOD IS COMPLETE AND THE DISPLAY IS UPDATED. ALWAYS ALLOW TWO GATE INDICATIONS ON A STEADY FREQUENCY INPUT SIGNAL BEFORE READING THE DISPLAY.

WHEN MEASURING AN UNKNOWN FREQUENCY, IT IS BEST TO START WITH THE "kHz" RANGE, AND ONLY SWITCH TO THE "MHz" RANGE IF AN OVERRANGE OCCURS (IF THE "OVER" INDICATOR ILLUMINATES).

THE DISPLAY CAN READ A MAXIMUM NUMERICAL VALUE OF 99.999, WITH THE NUMBER REPRESENTING EITHER KHz or MHz DEPENDING ON THE RANGE SWITCH SELECTION.

EVEN WHEN THE "OVER" INDICATOR IS ON, AS LONG AS THE ANTICIPATED INPUT FREQUENCY IS NOT AS HIGH AS TWICE THE CURRENTLY SELECTED RANGE, THE READING WILL STILL BE VALID. FOR EXAMPLE, IF AN INPUT OF 98.456 kHz IS BEING READ, AND THE FREQUENCY IS SEEN TO BE INCREASING FROM THERE, EVENTUALLY THE FREQUENCY MAY EXCEED 99.999 KHz AND THE "OVER" INDICATOR WILL ILLUMINATE. AT THIS POINT THE READOUT MIGHT FOR EXAMPLE SHOW 05.123, AND THE USER SHOULD RECALL THAT THE "OVER" INDICATOR MEANS THAT AT LEAST 100kHz WAS REACHED, SO THAT NEEDS TO BE ADDED TO THE CURRENT DISPLAY IN ORDER TO GET THE ACTUAL FREQUENCY VALUE, WHICH IN THSI EXAMPLE WOULD BE 105.123 kHz. IN THE MHz RANGE, READINGS TAKEN WHEN THE "OVER" INDICATOR IS ON SHOULD BE VIEWED WITH SOME SKEPTICISM BECAUSE THE ANALOG AND DIGITAL CIRCUITRY MIGHT BE UNRELIABLE ABOVE 100MHz. WHEN WORKING WITH HIGH FREQUENCIES ABOVE THE SPECIFIED 100MHz MAXIMUM, IS AS ADVISABLE TO OCCASIONALLY TEST THE COUNTER WITH A KNOWN AND RELIABLY ACCURATE HIGH FREQUENCY SOURCE ABOVE 100MHz TO VERIFY THAT THE COUNTER CIRCUITRY CAN STILL BE TRUSTED.

WHEN THE COUNTER IS IN THE MHz RANGE, THE RESOLUTION WILL BE +/– 1kHz, AND IN THE kHz RANGE THE RESOLUTION IS +/– 1Hz, WITH AN ADDITIONAL ERROR OF +/– THE TIME BASE (CLOCK OSCILLATOR) ACCURACY.

THE IB–1101'S CLOCK OSCILLATOR IS NOT EQUIPPED WITH A "CRYSTAL OVEN" TO KEEP THE CRYSTAL AT A CONSTANT TEMPERATURE FOR BEST STABILITY. IF A 1MHz FREQUENCY STANDARD (USING A CRYSTAL OVEN OR PERHAPS BASED ON OTHER HIGHLY STABLE AND ACCURATE PHYSICAL STANDARDS), IT MAY BE APPLIED TO THE REAR PANEL BNC "EXTERNAL STD INPUT" JACK; THE EXTERNAL SIGNAL WILL OVERWHELM THE INTERNAL CLOCK OSCILLATOR, AND THE COUNTER WILL USE THE EXTERNAL CLOCK SIGNAL INSTEAD.

SPECIFICATIONS

FREQUENCY RANGE: 1Hz TO AT LEAST 100MHz

ACCURACY: +/– 1 LEAST SIGNIFICANT DIGIT +/_ TIME BASE ACCURACY

SENSITIVITY: 50mV RMS UP TO 50MHz, 100mV FROM 50MHz UP TO 100MHz

GATE TIME: 1mS OR 1 SECOND, WITH AUTOMATIC RESET

INPUT IMPEDANCE: 1MΩ, SHUNTED BY LESS THAN 15pF

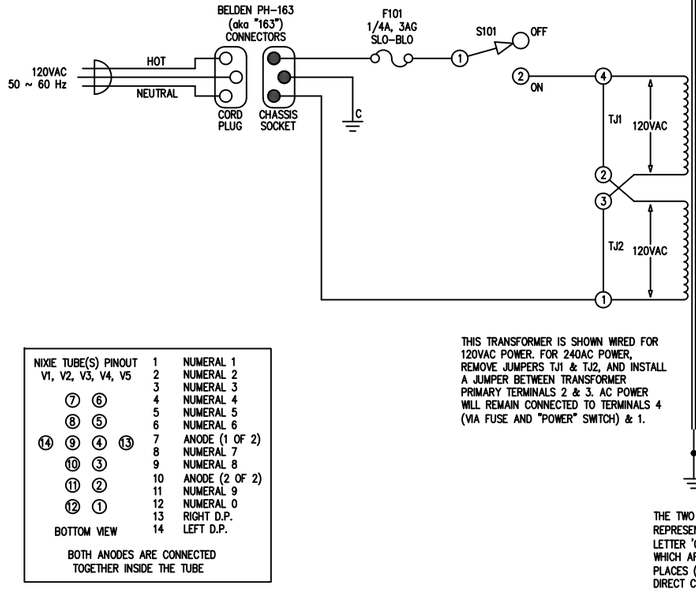
MAXIMUM INPUT VOLTAGE: 140V RMS AT 1Hz, GRADUALLY DERATED TO 3V RMS AT 100MHz (250 VDC MAX.)

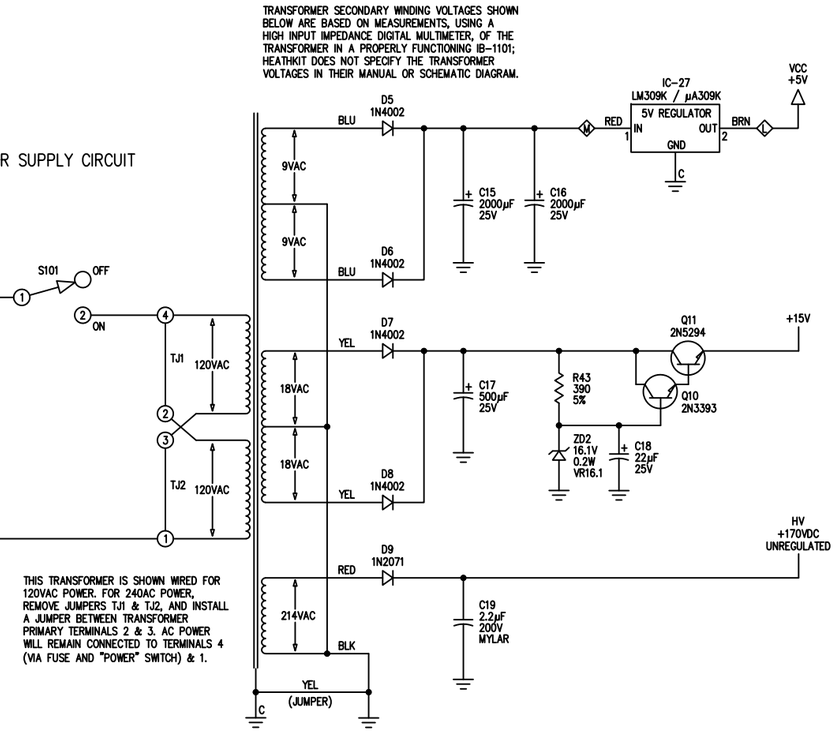
EXTERNAL STANDARD INPUT: 1MHz, 2.5V RMS TO 6.5V RMS, SINE OF SQUARE WAVE,
APPROXIMATELY 2.5KΩ, 70pF IMPEDANCE

TIME BASE FREQUENCY: 1MHz

TIME BASE STABILITY (AFTER 30 MINUTE WARMUP):
< +/– 3 PPM BETWEEN 17 DEGREES C AND 32 DEGREES C
< 1 PPM/MONTH AFTER 30 DAYS OF OPERATION
< +/– 20 PPM BETWEEN 0 DEGREES C AND 40 DEGREES C

GENERAL
SIZE: 3.375"H x 8.25"W x 9"D (NOT INCLUDING HANDLE)
WEIGHT: APPROX. 4.5 POUNDS
DISPLAY:
MAXIMUM COUNT: 99.000
COLD–CATHODE "NIXIE" TUBES AND NEAON BULBS
POWER REQUIREMENT:
VOLTAGE: 105~125VAC OR 210~250VAC
FREQUENCY: 50~60Hz
POWER DRAIN: 15W NOMINAL





ACTIVE COMPONENT IDENTIFICATION AND SUBSTITUTES

DIODES

IDENTIFIER	HEATH PN	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
D1,2,3	56–86	FD777		FAST DIODE, WORKING INVERSE 8V, 150mA FWD STEADY CURRENT
D4	56–61	GESTB	PLE1V5 (?)/2x 1N4148	"STABISTOR" DIODE, 1.2V FORWARD VOLTAGE (2x 0.6V)
D5,6,7,8	57–65	1N4002		GP RECTIFIER DIODE, PIV=100V, 1A
D9	57–27	1N2071	1N4005	GP RECTIFIER DIODE, PIV=600V, 1A

ZENER DIODES

IDENTIFIER	HEATH PN	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
ZD1	56–59	1N750A	1N4732A	4.7V ZENER, 500mW, 5% VOLTAGE TOLERANCE
ZD2	56–36	VR16.1	NZX16B,133	16.1V ZENER, 200mW

TRANSISTORS & VOLTAGE REGULATORS

IDENTIFIER	HEATH PN	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
Q1	417–288	2N4416	PN4416, J111	N–CHANNEL JFET, METAL CAN WITH EXTRA SHIELD LEAD
Q2,5,6	417–260	2N4258A	2N3646	PNP BJT, 12V, 50mA
Q3,7	417–125	2N3563		NPN BJT, 30V, 200mA
Q4	417–134	MPS6520		NPN BJT, 25V, 100mA
Q8,9	417–173	2N2509	ETS083	NPN BJT, 80V, 200mA
Q10	417–118	2N3393		NPN BJT, 25V, 500mA, 0.625W
Q11	417–175	2N5294	TA2911	NPN BJT, 75V, 4A
IC–27	442–30	µA309K	LM309K, LM340K	5V REGULATOR, 1.5A MAX WITH HEATSINK, TO–3 PACKAGE

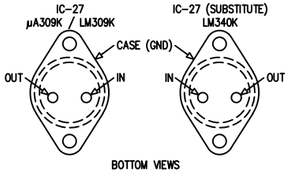
THE LM340K IS THE TO–3 VERSION OF THE 7805 5V REGULATOR. IT CAN SUBSTITUTE FOR THE µA309K OR LM309K, ALTHOUGH THE INPUT AND OUTPUT PINS ARE REVERSED; THE TO–3 CASE IS THE 'GROUND' CONNECTION FOR ALL THREE TYPES.

DISPLAYS

IDENTIFIER	HEATH PN	MANUFACTURER PN	POSSIBLE SUBSTITUTE	DESCRIPTION
V1,2,3,4,5	411–264	B–5859S	NL950S	NIXIE COLD–CATHODE TUBE (BURROUGHS & NATIONAL)
N1,2,3,4	412–49	NE–51H		NEON LAMP, USED FOR MHz, kHz, "OVER", "GATE" INDICATIONS

THE NEON BULB IDENTIFIERS N1 ~ N4 ARE NOT ACCORDING TO ORIGINAL HEATHKIT DOCUMENTATION, WHICH DID NOT ASSIGN THEM IDENTIFIERS

ALL IC's OTHER THAN IC–27 ARE TTL LOGIC DEVICES IN "DIP" PACKAGES. THEIR TYPE NUMBERS AND FUNCTIONALITY ARE SPECIFIED ON THE SCHEMATIC (SHEET 1), AND THEY ARE ALL TYPES THAT ARE STILL AVAILABLE, SO NO SUBSTITUTES ARE SUGGESTED HERE. IF THE PART NUMBER HAS AN 'S' OR 'H' IN THE MIDDLE, THIS IS CRITICAL AND MUST BE DUPLICATED WHEN CHOOSING SUBSTITUTES, ALTHOUGH 'LS' CAN USUALLY BE USED IN PLACE OF 'S'. IN MOST CASES, A SUFFIX OF 'B' OR 'N' IS NOT IMPORTANT. THE 'SN' PREFIX MEANS THE IC MANUFACTURER 'TEXAS INSTRUMENTS', BUT OTHER BRANDS MAY BE USED.



ALL OTHER CIRCUITRY IS SHOWN ON SHEET 1 OF THIS DRAWING

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE CORRECT, LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IB–1101. 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.

REVISION A 3–4–2024

HEATHKIT IB–1101 FREQUENCY COUNTER SCHEMATIC DIAGRAM

SHEET 2 OF 2