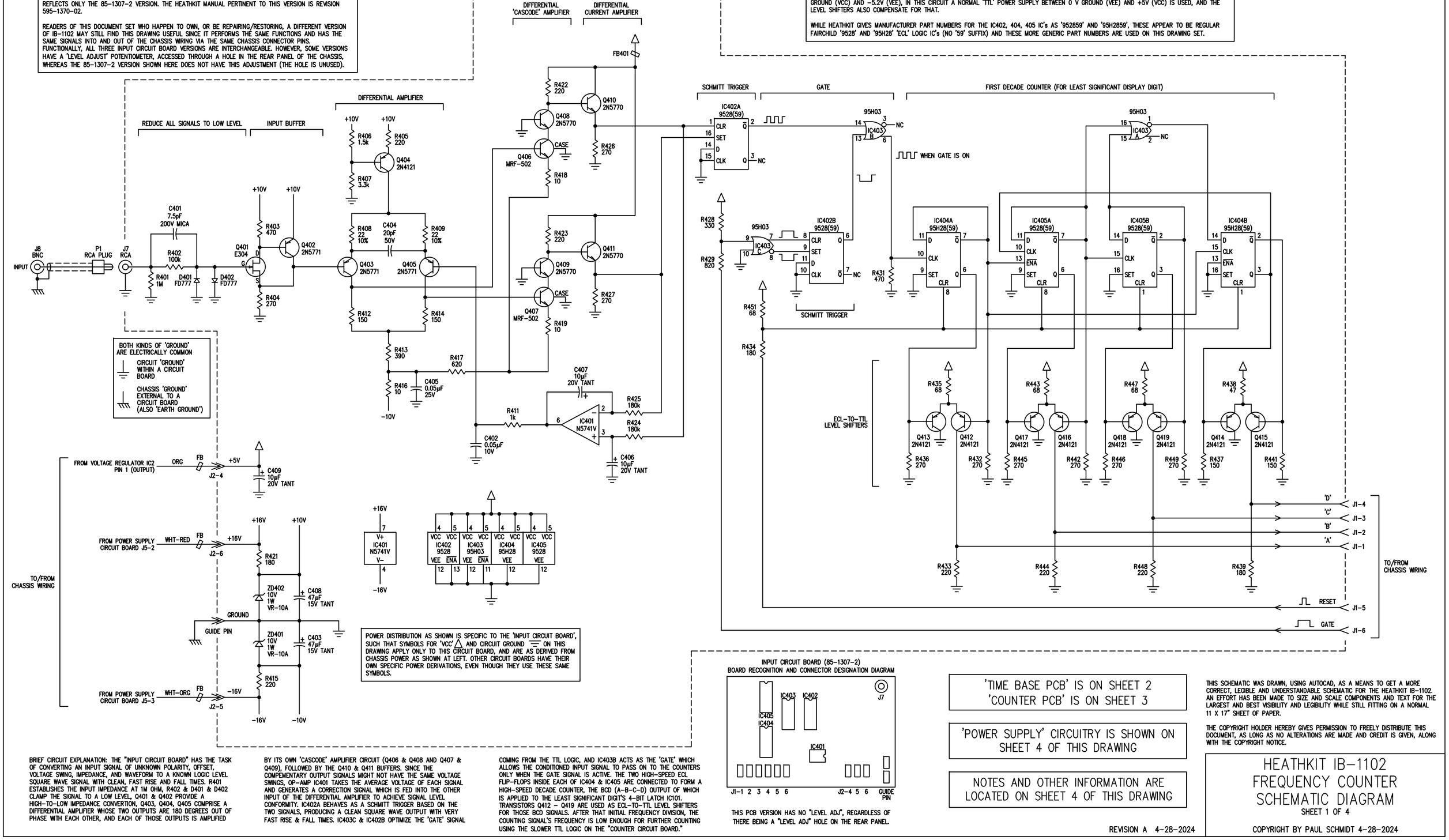
# INPUT CIRCUIT BOARD

THE IB-1102 FREQUENCY COUNTER, DURING ITS PRODUCTION PERIOD FROM 1972 THROUGH 1977, HAD VARIATIONS THAT INCLUDED THREE DIFFERENT 'INPUT CIRCUIT BOARD' DESIGNS, DESIGNATED 85-1307-1, 85-1307-2, AND 85-1307-3; THIS NUMBER IS SHOWN ON THE CIRCUIT BOARD'S SILKSCREEN. THIS DRAWING REFLECTS ONLY THE 85-1307-2 VERSION. THE HEATHKIT MANUAL PERTINENT TO THIS VERSION IS REVISION 595-1370-02.

READERS OF THIS DOCUMENT SET WHO HAPPEN TO OWN, OR BE REPAIRING/RESTORING, A DIFFERENT VERSION OF IB-1102 MAY STILL FIND THIS DRAWING USEFUL SINCE IT PERFORMS THE SAME FUNCTIONS AND HAS THE SAME SIGNALS INTO AND OUT OF THE CHASSIS WIRING VIA THE SAME CHASSIS CONNECTOR PINS. FUNCTIONALLY, ALL THREE INPUT CIRCUIT BOARD VERSIONS ARE INTERCHANGEABLE. HOWEVER, SOME VERSIONS HAVE A 'LEVEL ADJUST' POTENTIOMETER, ACCESSED THROUGH A HOLE IN THE REAR PANEL OF THE CHASSIS, WHEREAS THE 85-1307-2 VERSION SHOWN HERE DOES NOT HAVE THIS ADJUSTMENT (THE HOLE IS UNUSED).

ALL DIGITAL LOGIC IC'S ON THIS CIRCUIT BOARD (IC402, 403, 404, 405) ARE 'ECL' (EMITTER-COUPLED LOGIC), WHICH IS SIGNIFICANTLY FASTER THAN THE 'TTL' TYPE LOGIC IC'S USED ON THE "TIME BASE CIRCUIT BOARD" AND 'COUNTER CIRCUIT BOARD'. 'ECL' LOGIC USES DIFFERENT VOLTAGE LEVELS THAN 'TTL', AND THUS REQUIRES RESISTOR LEVEL SHIFTERS (FOR SIGNALS COMING FROM 'TTL' LOGIC) AND DUAL-TRANSISTOR LEVEL SHIFTERS (FOR SIGNALS GOING TO 'TTL' LOGIC). ALSO, WHILE THE 'ECL' IC'S HERE ARE INTENDED TO BE USED AT POWER SUPPLY VOLTAGES BETWEEN 0 VOLT GROUND (VCC) AND -5.2V (VEE), IN THIS CIRCUIT A NORMAL 'TTL' POWER SUPPLY BETWEEN 0 V GROUND (VEE) AND +5V (VCC) IS USED, AND THE LEVEL SHIFTERS ALSO COMPENSATE FOR THAT.

WHILE HEATHKIT GIVES MANUFACTURER PART NUMBERS FOR THE IC402, 404, 405 IC'S AS '952859' AND '95H2859', THESE APPEAR TO BE REGULAR FAIRCHILD '9528' AND '95H28' 'ECL' LOGIC IC'S (NO '59' SUFFIX) AND THESE MORE GENERIC PART NUMBERS ARE USED ON THIS DRAWING SET.




BRIEF CIRCUIT EXPLANATION: THE "INPUT CIRCUIT BOARD" HAS THE TASK OF CONVERTING AN INPUT SIGNAL OF UNKNOWN POLARITY, OFFSET, VOLTAGE SWING, IMPEDANCE, AND WAVEFORM TO A KNOWN LOGIC LEVEL SQUARE WAVE SIGNAL WITH CLEAN, FAST RISE AND FALL TIMES. R401 ESTABLISHES THE INPUT IMPEDANCE AT 1M OHM, R402 & D401 & D402 CLAMP THE SIGNAL TO A LOW LEVEL, Q401 & Q402 PROVIDE A HIGH-TO-LOW IMPEDANCE CONVERTION, Q403, Q404, Q405 COMPRISE A DIFFERENTIAL AMPLIFIER WHOSE TWO OUTPUTS ARE 180 DEGREES OUT OF PHASE WITH EACH OTHER, AND EACH OF THOSE OUTPUTS IS AMPLIFIED BY ITS OWN 'CASCODE' AMPLIFIER CIRCUIT (Q406 & Q408 AND Q407 & Q409), FOLLOWED BY THE Q410 & Q411 BUFFERS. SINCE THE COMPEMENTARY OUTPUT SIGNALS MIGHT NOT HAVE THE SAME VOLTAGE SWINGS, OP-AMP IC401 TAKES THE AVERAGE VOLTAGE OF EACH SIGNAL AND GENERATES A CORRECTION SIGNAL WHICH IS FED INTO THE OTHER INPUT OF THE DIFFERENTIAL AMPLIFIER TO ACHIEVE SIGNAL LEVEL CONFORMITY. IC402A BEHAVES AS A SCHMITT TRIGGER BASED ON THE TWO SIGNALS, PRODUCING A CLEAN SQUARE WAVE OUTPUT WITH VERY FAST RISE & FALL TIMES. IC403C & IC402B OPTIMIZE THE 'GATE' SIGNAL COMING FROM THE TTL LOGIC, AND IC403B ACTS AS THE 'GATE' WHICH ALLOWS THE CONDITIONED INPUT SIGNAL TO PASS ON TO THE COUNTERS ONLY WHEN THE GATE SIGNAL IS ACTIVE. THE TWO HIGH-SPEED ECL FLIP-FLOPS INSIDE EACH OF IC404 & IC405 ARE CONNECTED TO FORM A HIGH-SPEED DECADE COUNTER, THE BCD (A-B-C-D) OUTPUT OF WHICH IS APPLIED TO THE LEAST SIGNIFICANT DIGIT'S 4-BIT LATCH IC101. TRANSISTORS Q412 - Q419 ARE USED AS ECL-TO-TTL LEVEL SHIFTERS FOR THOSE BCD SIGNALS. AFTER THAT INITIAL FREQUENCY DIVISION, THE COUNTING SIGNAL'S FREQUENCY IS LOW ENOUGH FOR FURTHER COUNTING USING THE SLOWER TTL LOGIC ON THE "COUNTER CIRCUIT BOARD."

POWER DISTRIBUTION AS SHOWN IS SPECIFIC TO THE 'INPUT CIRCUIT BOARD', SUCH THAT SYMBOLS FOR 'VCC' △ AND CIRCUIT GROUND ⏚ ON THIS DRAWING APPLY ONLY TO THIS CIRCUIT BOARD, AND ARE AS DERIVED FROM CHASSIS POWER AS SHOWN AT LEFT. OTHER CIRCUIT BOARDS HAVE THEIR OWN SPECIFIC POWER DERIVATIONS, EVEN THOUGH THEY USE THESE SAME SYMBOLS.

INPUT CIRCUIT BOARD (85-1307-2)
BOARD RECOGNITION AND CONNECTOR DESIGNATION DIAGRAM




THIS PCB VERSION HAS NO "LEVEL ADJ", REGARDLESS OF THERE BEING A "LEVEL ADJ" HOLE ON THE REAR PANEL.

'TIME BASE PCB' IS ON SHEET 2
'COUNTER PCB' IS ON SHEET 3

'POWER SUPPLY' CIRCUITRY IS SHOWN ON SHEET 4 OF THIS DRAWING

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

REVISION A 4-28-2024

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE CORRECT, LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IB-1102. 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.



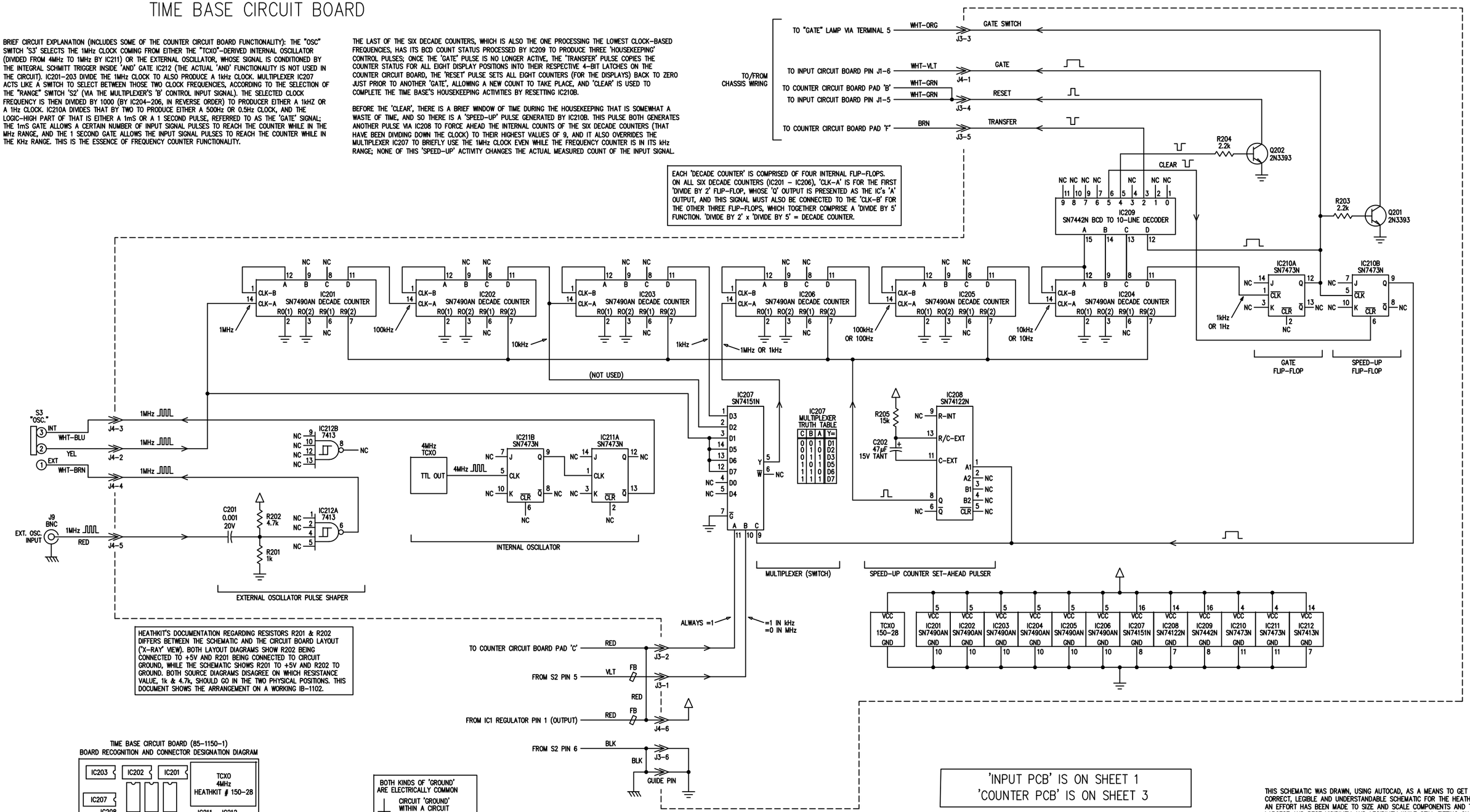
HEATHKIT IB-1102
FREQUENCY COUNTER
SCHEMATIC DIAGRAM
SHEET 1 OF 4

# TIME BASE CIRCUIT BOARD

BRIEF CIRCUIT EXPLANATION (INCLUDES SOME OF THE COUNTER CIRCUIT BOARD FUNCTIONALITY): THE "OSC" SWITCH 'S3' SELECTS THE 1MHz CLOCK COMING FROM EITHER THE "TCXO"-DERIVED INTERNAL OSCILLATOR (DIVIDED FROM 4MHz TO 1MHz BY IC211) OR THE EXTERNAL OSCILLATOR, WHOSE SIGNAL IS CONDITIONED BY THE INTEGRAL SCHMITT TRIGGER INSIDE 'AND' GATE IC212 (THE ACTUAL 'AND' FUNCTIONALITY IS NOT USED IN THE CIRCUIT). IC201–203 DIVIDE THE 1MHz CLOCK TO ALSO PRODUCE A 1kHz CLOCK. MULTIPLEXER IC207 ACTS LIKE A SWITCH TO SELECT BETWEEN THOSE TWO CLOCK FREQUENCIES, ACCORDING TO THE SELECTION OF THE "RANGE" SWITCH 'S2' (VIA THE MULTIPLEXER'S 'B' CONTROL INPUT SIGNAL). THE SELECTED CLOCK FREQUENCY IS THEN DIVIDED BY 1000 (BY IC204–206, IN REVERSE ORDER) TO PRODUCER EITHER A 1kHZ OR A 1Hz CLOCK. IC210A DIVIDES THAT BY TWO TO PRODUCE EITHER A 500Hz OR 0.5Hz CLOCK, AND THE LOGIC-HIGH PART OF THAT IS EITHER A 1mS OR A 1 SECOND PULSE, REFERRED TO AS THE 'GATE' SIGNAL; THE 1mS GATE ALLOWS A CERTAIN NUMBER OF INPUT SIGNAL PULSES TO REACH THE COUNTER WHILE IN THE MHz RANGE, AND THE 1 SECOND GATE ALLOWS THE INPUT SIGNAL PULSES TO REACH THE COUNTER WHILE IN THE KHz RANGE. THIS IS THE ESSENCE OF FREQUENCY COUNTER FUNCTIONALITY.

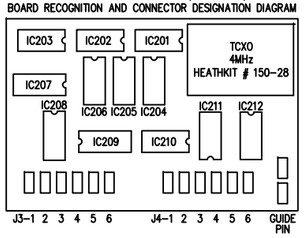
THE LAST OF THE SIX DECADE COUNTERS, WHICH IS ALSO THE ONE PROCESSING THE LOWEST CLOCK-BASED FREQUENCIES, HAS ITS BCD COUNT STATUS PROCESSED BY IC209 TO PRODUCE THREE 'HOUSEKEEPING' CONTROL PULSES; ONCE THE 'GATE' PULSE IS NO LONGER ACTIVE, THE 'TRANSFER' PULSE COPIES THE COUNTER STATUS FOR ALL EIGHT DISPLAY POSITIONS INTO THEIR RESPECTIVE 4-BIT LATCHES ON THE COUNTER CIRCUIT BOARD, THE 'RESET' PULSE SETS ALL EIGHT COUNTERS (FOR THE DISPLAYS) BACK TO ZERO JUST PRIOR TO ANOTHER 'GATE', ALLOWING A NEW COUNT TO TAKE PLACE, AND 'CLEAR' IS USED TO COMPLETE THE TIME BASE'S HOUSEKEEPING ACTIVITIES BY RESETTING IC210B.

BEFORE THE 'CLEAR', THERE IS A BRIEF WINDOW OF TIME DURING THE HOUSEKEEPING THAT IS SOMEWHAT A WASTE OF TIME, AND SO THERE IS A 'SPEED-UP' PULSE GENERATED BY IC210B. THIS PULSE BOTH GENERATES ANOTHER PULSE VIA IC208 TO FORCE AHEAD THE INTERNAL COUNTS OF THE SIX DECADE COUNTERS (THAT HAVE BEEN DIVIDING DOWN THE CLOCK) TO THEIR HIGHEST VALUES OF 9, AND IT ALSO OVERRIDES THE MULTIPLEXER IC207 TO BRIEFLY USE THE 1MHz CLOCK EVEN WHILE THE FREQUENCY COUNTER IS IN ITS kHz RANGE; NONE OF THIS 'SPEED-UP' ACTIVITY CHANGES THE ACTUAL MEASURED COUNT OF THE INPUT SIGNAL.




HEATHKIT'S DOCUMENTATION REGARDING RESISTORS R201 & R202 DIFFERS BETWEEN THE SCHEMATIC AND THE CIRCUIT BOARD LAYOUT ('X-RAY' VIEW). BOTH LAYOUT DIAGRAMS SHOW R202 BEING CONNECTED TO +5V AND R201 BEING CONNECTED TO CIRCUIT GROUND, WHILE THE SCHEMATIC SHOWS R201 TO +5V AND R202 TO GROUND. BOTH SOURCE DIAGRAMS DISAGREE ON WHICH RESISTANCE VALUE, 1k & 4.7k, SHOULD GO IN THE TWO PHYSICAL POSITIONS. THIS DOCUMENT SHOWS THE ARRANGEMENT ON A WORKING IB-1102.

TIME BASE CIRCUIT BOARD (85-1150-1)
BOARD RECOGNITION AND CONNECTOR DESIGNATION DIAGRAM




THE 'TXCO' IS A TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR, NOT A 'OCXO' "CRYSTAL OVEN"

BOTH KINDS OF 'GROUND' ARE ELECTRICALLY COMMON
- CIRCUIT 'GROUND' WITHIN A CIRCUIT BOARD
- CHASSIS 'GROUND' EXTERNAL TO A CIRCUIT BOARD (ALSO 'EARTH GROUND')

POWER DISTRIBUTION AS SHOWN IS SPECIFIC TO THE 'INPUT CIRCUIT BOARD', SUCH THAT SYMBOLS FOR 'VCC' △ AND CIRCUIT GROUND ⏚ ON THIS DRAWING APPLY ONLY TO THIS CIRCUIT BOARD, AND ARE AS DERIVED FROM CHASSIS POWER AS SHOWN ABOVE. OTHER CIRCUIT BOARDS HAVE THEIR OWN SPECIFIC POWER DERIVATIONS, EVEN THOUGH THEY USE THESE SAME SYMBOLS.

'INPUT PCB' IS ON SHEET 1
'COUNTER PCB' IS ON SHEET 3

'POWER SUPPLY' CIRCUITRY IS SHOWN ON SHEET 4 OF THIS DRAWING

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

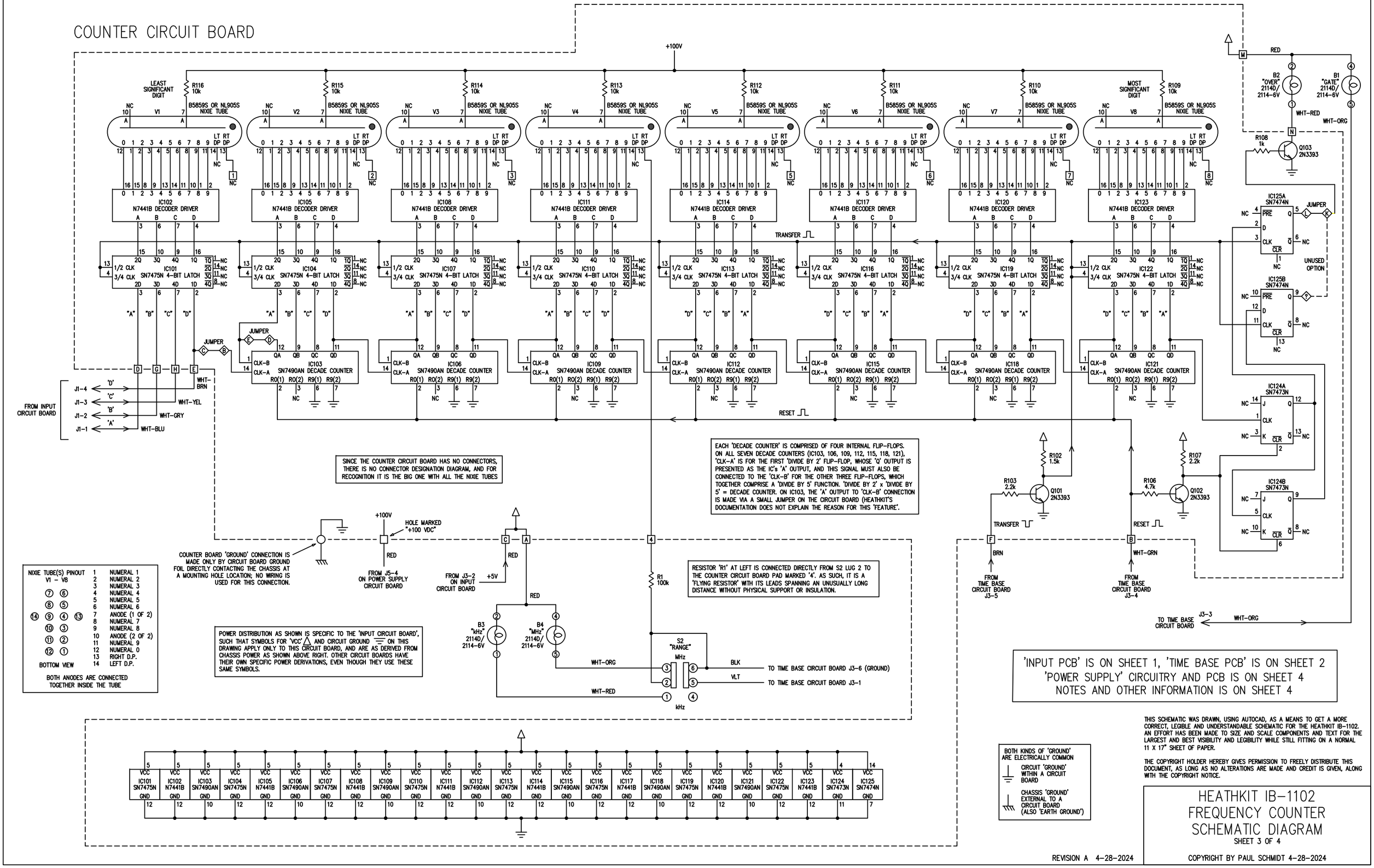


HEATHKIT IB-1102
FREQUENCY COUNTER
SCHEMATIC DIAGRAM
SHEET 2 OF 4



REVISION A 4-28-2024

# COUNTER CIRCUIT BOARD




'INPUT PCB' IS ON SHEET 1, 'TIME BASE PCB' IS ON SHEET 2
'POWER SUPPLY' CIRCUITRY AND PCB IS ON SHEET 4
NOTES AND OTHER INFORMATION IS ON SHEET 4

BOTH KINDS OF 'GROUND' ARE ELECTRICALLY COMMON

CIRCUIT 'GROUND' WITHIN A CIRCUIT BOARD

CHASSIS 'GROUND' EXTERNAL TO A CIRCUIT BOARD (ALSO 'EARTH GROUND')

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE CORRECT, LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IB-1102. 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 IB-1102 FREQUENCY COUNTER SCHEMATIC DIAGRAM

SHEET 3 OF 4



REVISION A 4-28-2024

## GENERAL NOTES (APPLICABLE TO ALL SHEETS OF THIS DRAWING)

1) RESISTORS ARE CARBON COMPOSITE (CC), 1/4W, 5% UNLESS INDICATED OTHERWISE. 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. SOME VERSION(S) OF THE "INPUT CIRCUIT BOARD" HAVE A TRIM POTENTIOMETER FOR "LEVEL ADJ", ACCESSED THROUGH A HOLE IN THE REAR PANEL OF THE CHASSIS; THIS SET OF SCHEMATICS DEPICT THE VERSION HAVING THE 85-1307-2 VERSION OF THE INPUT CIRCUIT BOARD, WHICH DOES NOT HAVE SUCH A POTENTIOMETER. RESISTOR IDENTIFIERS R100, R200, R300, R400 ARE NOT USED; ALSO SEE NOTE 10.
2) HEATHKIT DID NOT SPECIFY MOST CAPACITOR VOLTAGES IN THE MANUAL OR REPLACEMENT PARTS LIST, AND STUDY OF A WORKING IB-1102 COUNTER REVEALED THAT SOME CAPACITORS WERE NOT PHYSICALLY MARKED WITH THEIR VOLTAGE. CAPACITOR VOLTAGES SHOWN IN THIS SCHEMATIC ARE BASED ON EITHER MARKINGS ON THE PHYSICAL COMPONENT, OR OTHER SOURCES OF INFORMATION, OR JUST EDUCATED GUESSES. CAPACITORS ARE CERAMIC DISK TYPE UNLESS INDICATED OTHERWISE. CAPACITORS SHOWN AS POLARIZED (WITH +) ARE ALUMINUM ELECTROLYTIC TYPE, OR ARE TANTALUM TYPE IF MARKED "TANT". CAPACITOR IDENTIFIERS C200, C300, C400 ARE NOT USED; ALSO SEE NOTE 10.
3) THERE ARE ONLY TWO SWITCHES ON THE COUNTER'S FRONT PANEL, THE "POWER" SWITCH 'S1' AND THE "RANGE" SWITCH 'S2' (NEITHER OF WHICH IS GIVEN A NAME ON THE COUNTER'S FRONT PANEL OR IN THE HEATHKIT SCHEMATIC DIAGRAM). THE COUNTER'S REAR PANEL HAS A THIRD SWITCH 'S3', WHICH IS GIVEN THE NAME "OSC." (OSCILLATOR) FOR SELECTING THE INTERNAL OSCILLATOR OR AN EXTERNAL OSCILLATOR, AND IS SO-NAMED ON THE PANEL AND THE HEATHKIT SCHEMATIC.
4) DIGITAL IC'S HAVING MULTIPLE SECTIONS OR GATES (FLIP-FLOPS, 'AND' & 'OR' GATES) ARE DENOTED HEREIN WITH LETTER SUFFIXES, e.g. A, B, C, ACCORDING TO THE ORIGINAL HEATH SCHEMATIC. THESE SUFFIXES ARE ARBITRARY AND INCONSISTENTLY APPLIED, BUT ARE FAITHFULLY REPLICATED ON THIS DOCUMENT. THESE LETTERS ARE SHOWN AS A SUFFIX TO THE NORMAL IDENTIFIER, e.g. IC403A. A SIMILAR LOOKING LETTER SUFFIX ON OTHER ICS, e.g. SN7442N, IS MERELY A PART OF THE MANUFACTURER'S PART NUMBER.
5) A SQUARE DIAMOND SYMBOL WITH A SINGLE LETTER, e.g. ◈ REPRESENTS POINTS ON THE COUNTER CIRCUIT BOARD WHERE A SMALLER WIRE JUMPER IS USED TO SELECT OR ENABLE A PARTICULAR FUNCTION/OPTION. THE LETTERING MATCHES THE HEATHKIT DOCUMENTATION AND MARKINGS ON THE ACTUAL CIRCUIT BOARD.
6) A SQUARE SYMBOL WITH A SINGLE LETTER, OR SINGLE DIGIT, e.g. [A] OR [1] REPRESENTS POINTS ON THE 'COUNTER CIRCUIT BOARD' WHERE WIRES FROM CHASSIS-MOUNTED COMPONENTS OR OTHER CIRCUIT BOARDS ARE CONNECTED. THE LETTERING MATCHES THE HEATHKIT DOCUMENTATION AND MARKINGS ON THE ACTUAL CIRCUIT BOARD.
7) A SMALL CIRCLE SYMBOL WITH A SINGLE DIGIT, e.g. (3) REPRESENTS TERMINAL POINTS ON CHASSIS-MOUNTED COMPONENTS SUCH AS SWITCHES, TERMINALS FOR THE INDICATING LAMPS, THE POWER TRANSFORMER, THE VOLTAGE REGULATORS, ETC; AND MATCH HEATHKIT DOCUMENTATION.
8) A WEDGE ⩥ (PIN) OR ⩤ (SOCKET) OR A PAIR OF WEDGES ⩥⩤ (PIN & SOCKET) REPRESENTS CIRCUIT BOARD PLUG-IN CONNECTORS, WHERE A MALE PORTION (WITH PINS) IS MOUNTED TO THE CHASSIS AND WHERE THE FEMALE PORTION (SOCKETS) IS SOLDERED TO THE CIRCUIT BOARD TRACES/FOILS. DEPENDING ON THE SITUATION IN VARIOUS PARTS OF THE SCHEMATIC, ONLY ONE HALF OF EACH SUCH PLUG CONNECTION MAY BE SHOWN, OR BOTH MATING PARTS MAY BE SHOWN; CROSS REFERENCES IN TEXT ARE USED TO ASSIST IN UNDERSTANDING THE CONNECTIONS MADE AND WHERE THE MATING PORTION MAY BE FOUND.
9) A SMALLER WEDGE SYMBOL > LOCATED ON A SIGNAL-CARRYING SCHEMATIC LINE IS USED TO ASSIST IN UNDERSTANDING THE 'FLOW' OF CERTAIN SIGNALS, WHEREVER IT WAS THOUGHT THE SITUATION MIGHT REQUIRE MORE THOUGHT THAN SOME MIGHT CONSIDER TO BE HEALTHY. THIS SYMBOL IS OFTEN APPLIED IN DIGITAL CIRCUITS WHERE A SIGNAL IS GOING MANY PLACES AND IT MIGHT BE EASY TO LOSE TRACK OF WHERE IT ORIGINATES AND WHERE IT IS GOING TO, AND THUS WHICH 'DIRECTION' THE DATA IS MOVING. THE SYMBOL IS ALSO USED FOR CERTAIN SIGNALS GOING INTO, OR COMING OUT FROM, CIRCUIT BOARDS VIA THEIR PLUG CONNECTORS OR OTHER CONNECTIONS, ALTHOUGH 'DIRECTION' HERE DOES NOT NECESSARILY MEAN THE SAME THING AS 'CURRENT FLOW' ABD THE TWO MIGHT BE IN DIFFERENT DIRECTIONS.
10) COMPONENT IDENTIFIERS ARE 'GEOGRAPHICAL' IN NATURE. COMPONENTS WITH IDENTIFIERS LESS THAN 100 ARE CHASSIS MOUNTED OR ARE ON CHASSIS-MOUNTED COMPONENTS OTHER THAN CIRCUIT BOARDS. IDENTIFIERS IN THE 100s ARE LOCATED ON THE "COUNTER CIRCUIT BOARD", IDENTIFIERS IN THE 200s ARE LOCATED ON THE "TIME BASE CIRCUIT BOARD", IN THE 300s ARE ON THE "POWER SUPPLY CIRCUIT BOARD", AND IN THE 400s ARE ON THE "INPUT CIRCUIT BOARD". WITH FEW EXCEPTIONS, COMPONENT IDENTIFIERS THAT END WITH A '0' ARE UNUSED, e.g. R400, R410, R420, ETC; ARE UNUSED.
11) WHERE WIRE COLORS ARE SHOWN, THEY MATCH THE HEATHKIT DOCUMENTATION AND THE PHYSICAL IB-1102 INSPECTED IN PREPARATION FOR MAKING THIS DOCUMENT.
12) SEVERAL FERRITE BEADS ARE USED IN THE CIRCUIT IN ORDER TO SUPPRESS HIGH FREQUENCY DISTURBANCES. FIVE ARE LOCATED ON POWER SUPPLY-RELATED CHASSIS WIRING, AND ARE DESIGNATED SIMPLY WITH THE IDENTIFIER 'FB'. ONE MORE, OF A DIFFERENT TYPE FROM THE OTHERS, IS FITTED AROUND A JUMPER THAT IS LOCATED ON THE "INPUT CIRCUIT BOARD", AND IS GIVEN THE IDENTIFIER 'FB401' IN ACCORDANCE WITH THE GEOGRAPHIC IDENTIFIER NUMBERING SCHEME.
13) POWER SUPPLY DISTRIBUTION FOR THE IC'S HAS HEREIN BEEN SHOWN GROUPED TOGETHER NEAR THE BOTTOM OF RELEVANT SHEETS, RATHER THAN HAVE THEM CLUTTERING UP THE REST OF THE FUNCTIONAL SCHEMATIC.
14) THE ORIGINAL HEATHKIT SCHEMATIC HAD MANY ERRORS, ESPECIALLY IN REGARD TO DUPLICATED COMPONENT IDENTIFIERS, ERRONEOUS 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-1102'S CIRCUIT BOARDS AND CHASSIS, AND THE HEATHKIT MANUAL'S "CIRCUIT BOARD X-RAY VIEW" DIAGRAMS.
15) 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 FAIRCHILD AND TEXAS INSTRUMENT IC DATASHEETS.
16) FOR THE 'ECL' LOGIC ICs, HEATHKIT SHOWS MANUFACTURER PART NUMBERS THAT ARE IMPOSSIBLE TO FIND DATASHEETS FOR THESE DAYS. AS HEATHKIT IDENTIFIES THESE AS BEING SOURCED FROM FAIRCHILD OR SIGNETICS, PERIOD-APPROPRIATE DATABOOKS AND CATALOGS FOR THOSE IC SERIES WERE STUDIED, AND IT APPEARS THAT HEATHKIT'S VERSIONS HAVE AN ADDED SUFFIX OF '59', e.g. A FAIRCHILD 95H28 IS REFERRED TO AS 95H2859 BY HEATHKIT. WHEN PREPARING THESE NEW DOCUMENTS, THE FAIRCHILD DATABOOKS FROM THE EARLY 1970s WERE USED, STUDIED FOR PART NUMBERS WITHOUT THE '59' SUFFIX.

## SIMPLIFIED CALIBRATION PROCEDURE

1) THE FOLLOWING ASSUMES THAT THE IB-1102 IN QUESTION IS EQUIPPED WITH A SPECIFIC VERSION OF THE "INPUT CIRCUIT BOARD", SPECIFICALLY THE 85-1307-2, WHICH HAS ONLY ONE ADJUSTMENT. PRODUCT VERSIONS HAVING THE 85-1307-1 OR 85-1307-3 'INPUT CIRCUIT BOARD' (REPORTEDLY THEY ARE RELATIVELY UNCOMMON) ARE NOT COVERED BY THIS NEW SET OF DOCUMENTS (NO EXAMPLES OF IB-1102 WITH THOSE OTHER CIRCUIT BOARD VERSIONS WERE AVAILABLE FOR STUDY).
2) BEFORE BEGINNING THE CALIBRATION PROCEDURE, TURN THE COUNTER ON AND ALLOW IT TO WARM UP FOR AT LEAST 30 MINUTES; DO THIS WITH THE CHASSIS COVERS CLOSED.
3) THE ONLY ADJUSTMENT IS THE "OSC ADJUST", WHICH IS LOCATED INSIDE THE "TCXO" OSCILLATOR PACKAGE ON THE "INPUT CIRCUIT BOARD", AND ACCESSED BY SCREWDRIVER THROUGH A HOLE IN THE REAR OF THE CHASSIS.
4) THE "TCXO" IS FACTORY CALIBRATED AND SHOULD NOT REQUIRE CALIBRATION BY THE USER. HOWEVER, SINCE THIS NEW DOCUMENTATION SET IS INTENDED FOR USERS OR RESTORERS OF VINTAGE AND/OR USED EQUIPMENT, WITH UNKNOWN PASTS INCLUDING POTENTIAL FOR CARELESS USER ADJUSTMENTS, THE FOLLOWING SHOULD GET THINGS WORKING AGAIN.
5) CONNECT THE "INPUT" BNC CONNECTOR ON THE FRONT PANEL TO A RELIABLE & ACCURATE 'LABORATORY REFERENCE' SOURCE OF A 1MHz WAVEFORM (SQUARE WAVE PREFERRED, SINE WAVE ACCEPTABLE), AND IN A LOW VOLTAGE BELOW ABOUT 10V. CAREFULLY TWEAK THE "OSC ADJUST" UNTIL THE COUNTER'S READOUT (IN kHz RANGE) IS 1000.000, PLUS OR MINUS ONE LEAST SIGNIFICANT DIGIT. IF THE REFERENCE SOURCE IS ACCURATE AND STABLE BUT NOT EXACTLY 1MHz, THEN ADJUST FOR A DISPLAY READOUT MATCHING WHATEVER THE SOURCE'S OWN READOUT SHOWS.

## BASIC COUNTER OPERATION

THE IB-1102 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 POWER 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 POWER 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 WILL BE SO RAPID AS TO SEEM INVISIBLE.

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 120VRMS AT LOWER FREQUENCIES, BUT ABOVE 20MHz THE MAXIMUM ALLOWED VOLTAGE INPUT GRADUALLY DROPS TO ONLY ABOUT 20VRMS AT 100MHz AND ABOVE.

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 TWO GATE PERIODS ARE 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 99999.999, WITH THE NUMBER REPRESENTING EITHER KHz or MHz DEPENDING ON THE RANGE SWITCH SELECTION. THE DECIMAL POINT IS ALWAYS IN THE SAME POSITION.

UNLIKE SOME OTHER HEATHKIT COUNTERS IN THE SAME SERIES, THE IB-1102 IS NOT DESIGNED TO ALLOW ACCURATE READINGS OVER ITS SPECIFIED 120MHz MAXIMUM (BY 'CHEATING' AND ASSUMING THAT THE "OVER" LAMP MERELY MEANS THAT THE USER SHOULD ASSUME AN EXTRA '1' IN A POSITION JUST LEFT OF THE MOST SIGNIFICANT DISPLAYED DIGIT AND READ THE LESS SIGNIFICANT FREQUENCY DIGITS FROM THE DISPLAY); THE IB-1102 CANNOT BE RELIED ON TO BE USED IN THAT MANNER AND STILL GIVE USEFUL FREQUENCY VALUES.

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

THE IB-1101'S CLOCK OSCILLATOR IS NOT EQUIPPED WITH A "OCXO" OR "CRYSTAL OVEN" TO KEEP THE CRYSTAL AT A CONSTANT TEMPERATURE FOR BEST STABILITY. HOWEVER, IT USES A "TCXO" (TEMPERATURE COMPENSATED CRYSTAL OSCILLATOR) WHICH APPROACHES THE TEMPERATURE STABILITY OF AN "OCXO". IF A 1MHz FREQUENCY STANDARD (USING A CRYSTAL OVEN OR PERHAPS BASED ON OTHER HIGHLY STABLE AND ACCURATE PHYSICAL STANDARDS) IS AVAILABLE, IT MAY BE APPLIED TO THE REAR PANEL EXTERNAL STANDARD "INPUT" BNC JACK, AND THEN THE REAR PANEL 'S3' "OSC" SWITCH MOVED TO ITS "EXT" POSITION; THE COUNTER WILL THEN USE THE EXTERNAL CLOCK SIGNAL INSTEAD OF ITS INTERNAL "TCXO" OSCILLATOR. BE SURE TO MOVE THE SWITCH BACK TO ITS NORMAL "INT" POSITION AFTER USING AN EXTERNAL OSCILLATOR.

## SPECIFICATIONS

FREQUENCY RANGE: 1Hz TO 120MHz

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

SENSITIVITY: 50mV MAXIMUM

INPUT COUPLING: DC

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

INPUT IMPEDANCE: 1MΩ, SHUNTED BY 35pF

TRIGGER LEVEL: AUTOMATIC

MAXIMUM INPUT VOLTAGE: 120VRMS AT 1Hz AND UP TO 20MHz, THEN GRADUALLY DERATED TO 20V RMS AT 100MHz AND ABOVE

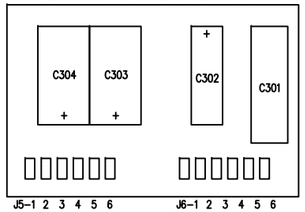
EXTERNAL STANDARD (REAR PANEL EXTERNAL OSCILLATOR "INPUT": 1MHz, 3VRMS MAXIMUM, SINE OR SQUARE WAVE, 1KΩ IMPEDANCE

TIME BASE FREQUENCY: 4MHz, DIVIDED DOWN TO 1MHz BEFORE USE

TIME BASE STABILITY (AFTER 30 MINUTE WARMUP):
- < +/- 1 PPM, BETWEEN 15 AND 50 DEGREES C
- < AGING RATE OF +/- 1 PPM/YEAR
- < SHORT TERM STABILITY BETTER THAN 0.5 PPM IN 1 SECOND
- < 0.5 PPM WITHIN A +/- 10% LINE VOLTAGE VARIATION

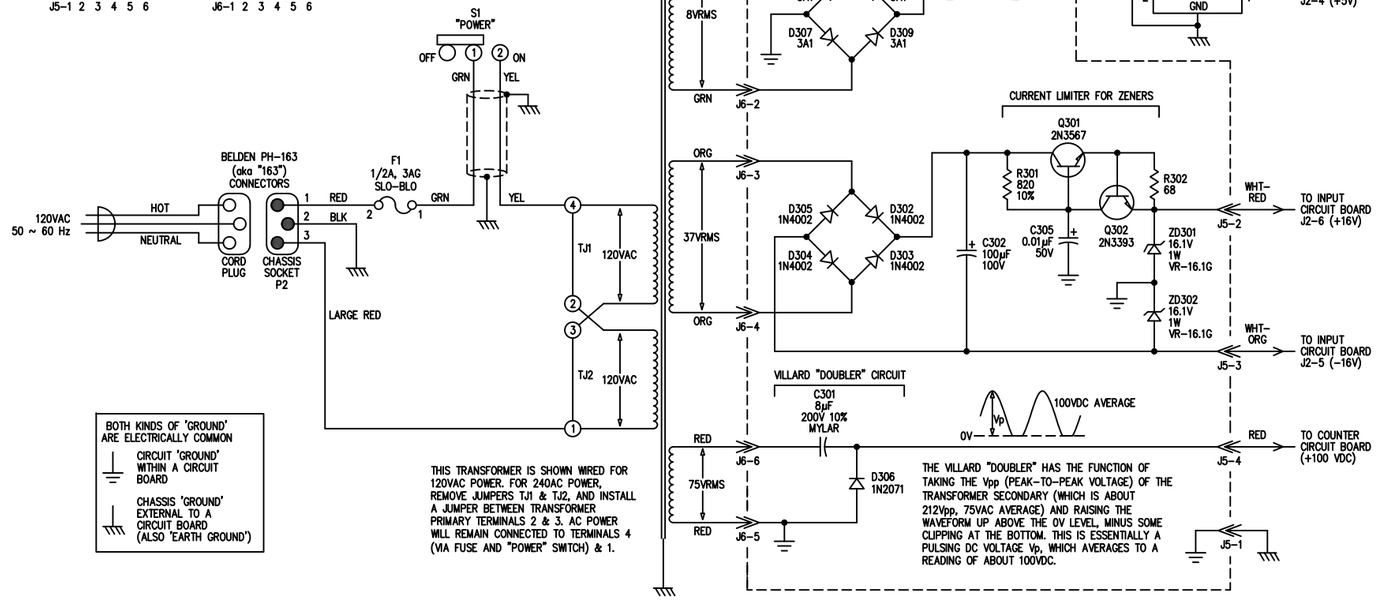
GENERAL
- SIZE: 3.625"H x 8.625"W x 9.25"D (NOT INCLUDING HANDLE)
- WEIGHT: APPROX. 8.25 POUNDS
- DISPLAY:
  - MAXIMUM COUNT: 99999.999
  - COLD-CATHODE "NIXIE" DISPLAY TUBES, AND INCANDESCENT BULBS FOR INDICATORS
- OPERATING TEMPERATURE RANGE: 10 TO 40 DEGREES C
- POWER REQUIREMENT:
  - VOLTAGE: 110-130VAC OR 220~260VAC
  - FREQUENCY: 50~60Hz
  - POWER DRAIN: 30W NOMINAL

POWER SUPPLY CIRCUIT BOARD (85-1215-1)
BOARD RECOGNITION AND CONNECTOR DESIGNATION DIAGRAM




Q301 & Q302 EXPLANATION: R301 PROVIDES BASE CURRENT TO TURN 'PASS TRANSISTOR' Q301 ON, THUS SUPPLYING POWER, VIA CURRENT SENSE RESISTOR R302, TO THE ZENER DIODES. IF THIS CURRENT IS HIGH ENOUGH THAT THE VOLTAGE DROP ACROSS R302 IS GREATER THAN ABOUT 0.6V, THIS IS SUFFICIENT TO START TURNING Q302 ON, WHICH STEALS SOME OF Q301's BASE CURRENT, SO THAT IT BEGINS TO TURN OFF AND THUS REDUCES CURRENT TO THE ZENERS.

# POWER SUPPLY CIRCUIT BOARD




## ACTIVE COMPONENT IDENTIFICATION AND SUBSTITUTES

DIODES

| IDENTIFIER | HEATH PN | MANUFACTURER PN | POSSIBLE SUBSTITUTE | DESCRIPTION |
|---|---|---|---|---|
| D401, 402 | 56-86 | FD777 | | FAST DIODE, WORKING INVERSE 8V, 150mA FWD STEADY CURRENT |
| D307-310 | 57-42 | 3A1 | 1N5403 | SILICON DIODE, PIV=300V, 3A |
| D302-305 | 57-65 | 1N4002 | | GP RECTIFIER DIODE, PIV=100V, 1A |
| D306 | 57-27 | 1N2071 | 1N4005 | GP RECTIFIER DIODE, PIV=600V, 1A |

ZENER DIODES

| IDENTIFIER | HEATH PN | MANUFACTURER PN | POSSIBLE SUBSTITUTE | DESCRIPTION |
|---|---|---|---|---|
| ZD401, 402 | 56-67 | VR-10A | 1N4740A | 10V ZENER, 1W |
| ZD301, 302 | 56-36 | VR-16.1G | 1N4745A | 16.1V ZENER, 1W |

TRANSISTORS & VOLTAGE REGULATORS

| IDENTIFIER | HEATH PN | MANUFACTURER PN | POSSIBLE SUBSTITUTE | DESCRIPTION |
|---|---|---|---|---|
| Q401 | 417-802 | E304 | 2N4416, 2N5245 (N1) | N-CHANNEL JFET, 30V, 15mA |
| Q406, 407 | 417-290 | MRF-502 | 2N708 (N2) | NPN BJT, 35V, 50mA |
| Q301 | 417-114 | 2N3567 | KSC1008YBU | NPN BJT, 40V, 500mA |
| Q408-411 | 417-293 | 2N5770 | | NPN BJT, 30V, 50mA, 0.630W |
| Q402,403,405, 414, 415 | 417-292 | 2N5771 | | PNP BJT, 30V, 50mA, 0.630W |
| Q101-103, Q201-202, Q302 | 417-118 | 2N3393 | | NPN BJT, 25V, 500mA, 0.625W |
| Q404,412-413, 416-419 | 417-235 | 2N4121 | BC212 | NPN BJT, 40V, 200mA |
| IC1, IC2 | 442-30 | µA309K | LM309K, LM340K (N3) | 5V REGULATOR, 1.5A MAX WITH HEATSINK, TO-3 PACKAGE |

N1: THE 2N4416 IS 5mA COMPARED TO ORIGINAL'S 15mA, BUT PINOUT IS THE SAME, WHILE 2N5245 IS 15mA BUT WITH WRONG PINOUT.
N2: THE 2N708 HAS THE CORRECT SPECIFICATIONS, BUT THE PINOUT IS WRONG.
N3: 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.

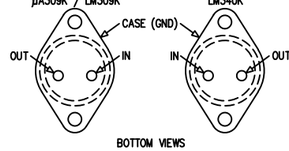
DISPLAYS

| IDENTIFIER | HEATH PN | MANUFACTURER PN | POSSIBLE SUBSTITUTE | DESCRIPTION |
|---|---|---|---|---|
| V1-V8 | 411-264 | B-5859S | NL950S | NIXIE COLD-CATHODE TUBE (BURROUGHS & NATIONAL) |
| B1-B4 | 412-31 | 2114D | 2114-6V | SUBMINIATURE INCANDESCENT BULB, 6V |

THE LIGHT BULB IDENTIFIERS B1 ~ B4 ARE NOT ACCORDING TO ORIGINAL HEATHKIT DOCUMENTATION, WHICH DID NOT ASSIGN THEM IDENTIFIERS.

INTEGRATED CIRCUITS

ALL DIGITAL IC's OTHER THAN THE 'ECL' ICS ON THE "INPUT CIRCUIT BOARD" ARE TTL LOGIC DEVICES IN "DIP" PACKAGES. THEIR TYPE NUMBERS AND FUNCTIONALITY ARE SPECIFIED ON THE SCHEMATIC (SHEETS 2 & 3), AND THEY ARE ALL TYPES THAT ARE STILL AVAILABLE, SO NO SUBSTITUTES ARE SUGGESTED HERE. 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. THE IC401 OP-AMP IS LISTED AS AN 'N5741V' TYPE, BUT THIS APPEARS TO BE A 741 OP-AMP, ALTHOUGH IT IS RECOMMENED THAT FASTER MODERN VERSIONS BE USED AS SUBSTITUTES.




BOTTOM VIEWS

'INPUT PCB' IS ON SHEET 1
'TIME BASE PCB' IS ON SHEET 2
'COUNTER PCB' IS ON SHEET 3

THIS SCHEMATIC WAS DRAWN, USING AUTOCAD, AS A MEANS TO GET A MORE CORRECT, LEGIBLE AND UNDERSTANDABLE SCHEMATIC FOR THE HEATHKIT IB-1102. 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 IB-1102 FREQUENCY COUNTER SCHEMATIC DIAGRAM

SHEET 4 OF 4

REVISION A 4-28-2024