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PRELIMINARY INSTRUCTION MANUAL

MODEL 5020

DIGITAL MULTI-FUNCTION METER

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Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

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SECTION I

INTRODUCTION AND SPECIFICATIONS

The NLS Model 5020 Digital Multi-Function Meter is designed for users who require a highly accurate, easily-maintained instrument possessing a high order of reliability. The leading particulars of this instrument are here summarized to illustrate how NLS has met user demand, and to familiarize the reader with the instrument.

SCOPE OF MANUAL

The unit may be obtained in three different versions. The most complete version measures volts DC, volts AC, ohms and ratio; another measures volts DC, ohms and ratio; and the third version (without preamplifier) measures volts DC and one range of ratio. The discussion throughout the manual will be directed toward the most complete version of the Model 5020. Users possessing other versions of the instrument may simply disregard the portions of the manual pertaining to measurement functions not included in their particular instrument. Table 1-1 lists the measurement functions of each version with their major assemblies.

Table 1-1. Versions of the Model 5020 with Major Assemblies

Major Assemblies	Measurement Functions		
	Volts DC, Volts AC, Ohms & Ratio (P/N 50-193)	Volts DC, Ohms & Ratio (P/N 50-335)	Volts DC & One Range of Ratio (P/N 50-336)
Main Board	50-244	50-244	50-244
Decade Board	50-61	50-61	50-61
5th Decade Board	50-114	50-114	50-114
Amplifier Board	50-177	50-177	50-177
Logic Board	50-191	50-191	50-191
Power Supply Board	50-7	50-7	50-7
Pre-Amplifier Board	50-127	50-127	------
Input Switching Board	50-172	50-172	------
Pre-Amplifier Power Supply Board	50-250	50-250	------
AC Attenuator & Converter Board	50-148	------	------
Auto Range & Counter Board	50-237	50-237	50-341
Delay & Driver Board	50-242	50-242	50-242

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Table 1-1. Versions of the Model 5020 with Major Assemblies (Continued)

Major Assemblies	Measurement Functions: Volts DC, Volts AC, Ohms & Ratio (P/N 50-193)	Volts DC, Ohms & Ratio (P/N 50-335)	Volts DC & One Range of Ratio (P/N 50-336)
Jumper Board (Replaces Input Switching Board)	------	------	50-340
Function Relay Board (S/N 5020.819 and on)	50-303	50-303	50-303

ACCURATE AND STABLE

A stable, built-in pre-amplifier permits routine measurements with a resolution of one microvolt on the 99.999-millivolt range and 10 microvolts resolution on the .99999-volt range. The pre-amplifier is not used in the 10, 100, and 1000 DC voltage ranges, but is used in the two lower DC ratio ranges as well as all ohms and AC voltage ranges. The ohms and AC volts converters are built on separate plug-in etched circuit boards.

DC VOLTS MODE

In the DC microvolts, millivolts and volts mode of measurement, the Model 5020 operates as a laboratory potentiometer which has been automated with the time-proven tracking logic. Ultra-stable, carefully selected matched and aged Zener diodes provide the self-balancing digital potentiometer excitation voltage. A temperature-controlled oven is not required. Using a relay-operated voltage divider, energized by a 10-volt Zener reference voltage, the instrument creates a known precision feedback voltage which is equal to the unknown input. The value of the known voltage is determined by the settings of the relays in the voltage divider which also control the readout display of the known voltage. Thus, when the meter is balanced, the known voltage displayed in the readout is equal to the unknown voltage.

AC VOLTS MODE

In the AC volts mode, the instrument operates in the same manner as in the DC volts mode except that the AC input signal is first routed through the AC Attenuator and Converter Assembly to convert the AC voltage into DC.

OHMS MODE

In the ohms mode, a constant current generator, within the Model 5020, supplies current through an unknown resistor. The resistance of the unknown resistor is directly proportional to the voltage across the resistor. Thus, by measuring the voltage we are actually measuring the resistance.

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RATIO MODE

In the ratio mode, the Model 5020 operates in the same way as in the DC volts mode, except that the signal voltage is derived from the external reference voltage which replaces the internal Zener reference voltage.

EASY TO SERVICE

Virtually all components are mounted on plug-in circuit boards for easiest access and replacement. It is thus possible to keep the Model 5020 operative with a minimum of down time. Hours spend in troubleshooting activities are now replaced by minutes spent in module replacement. For example, logic and feedback voltage generator circuits, common to any one decade (readout window), are mounted on a separate board and decades 1, 2, 3, and 4 are interchangeable; decade 5 will fit into any of the five positions, but the mating connector for decade 5 will not receive the decade 1, 2, 3, or 4 boards.

COMMON-MODE REJECTION

Rejection of common-mode signals, those caused by AC or DC currents flowing between signal source ground and instrument case ground, is a key feature of the Model 5020. Common-mode signal rejection is important in a wide range of applications - testing complex electrical and electronic systems, in automatic measuring outputs from thermocouples, strain gauges and other transducers where common-mode signals may be many times greater than the measured DC voltage.

In the Model 5020, 60 CPS common-mode signals of 80 DB with filter out and 120 DB with filter in will have no effect upon measurement accuracy even with up to 1,000 ohms source unbalance in either side of the input line. This feature is attained because the measuring circuits are isolated from the outer case by a metal guard shield that breaks the common-mode current loop and because the power supply is isolated from the power line.

FLOATING INPUT

Because input signal leads are not connected to the outer case of the Model 5020, signal-to-case potentials up to 500 volts are tolerable. Floating input adds to the unit's versatility by permitting it to measure voltage sources which could not be accurately measured by a non-isolated meter.

PRINTED CIRCUIT BOARDS

Epoxy fiberglass, rather than phenolic printed-circuit boards, are used throughout the instrument to minimize circuit breakage caused by expansion and contraction. For additional mechanical and electrical stability, the Printact relays used in the instruments are mounted on individual circuit boards. These small relay boards are not subject to many of the mechanical stresses which act upon the larger component boards, and therefore, the relay contact surfaces are more likely to stay in alignment. Electrical contact quality is assured, not only by alignment, but also by the use of precious metal contact surfaces on both the printed circuit board and the relay contacts.

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DIGITAL READOUT

The readout is the time-proven NLS lucite-panel, edge-lighted type in which each decade is housed in a separate module. The lamps used in this readout have been expressly designed for use in NLS readouts to combine high brilliance with long life. Since the lamps operate at transistor voltages, there is no electrical shock hazard to the user.

DIGITAL OUTPUT AND REMOTE CONTROL

The standard Model 5020 does not provide digital output or remote control connections, however, since many users desire these optional capabilities, information for printout function and remote control is provided in this manual. See figure 1-1 and schematics 50-67 and 50-337 for digital output information and figure 1-2 for remote control connections.

The NLS Sales Representatives or Engineering Department will be pleased to assist you with specific application problems and, of course, will gladly welcome your comments and suggestions. A contact with the nearest NLS office or to the main office in Del Mar, California will bring prompt response.

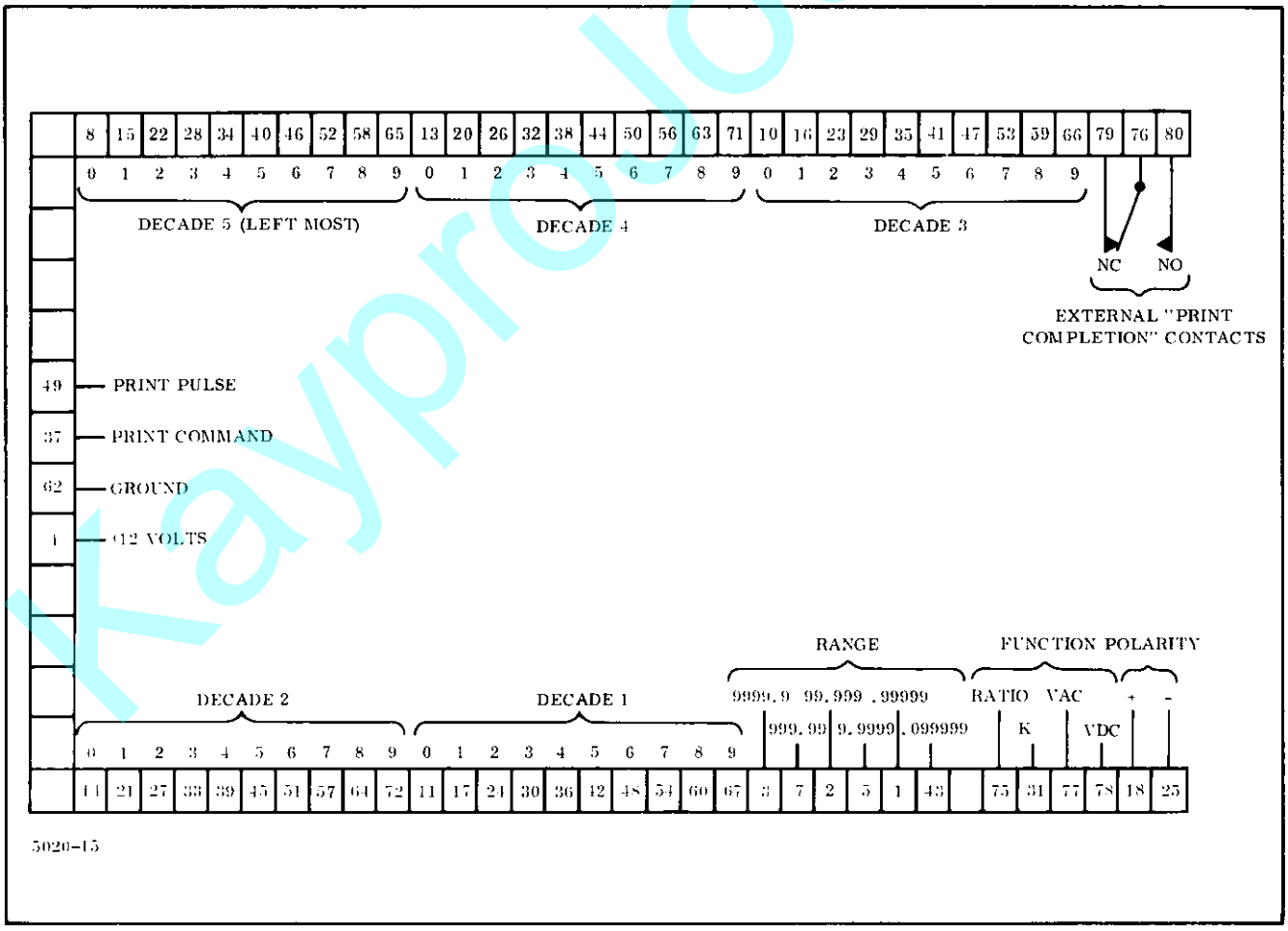

Figure 1-1. Digital Output Connections

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SPECIFICATIONS

RANGE NO.	FULL SCALE READOUT DISPLAY	DC VOLTAGE MEASUREMENTS		DC RATIO		OHMS		AC VOLTS	
		FULL SCALE DISPLAY	RESOLUTION	FULL SCALE DISPLAY	MEASUREMENT RESOLUTION	FULL SCALE DISPLAY	RESOLUTION	FULL SCALE DISPLAY	RESOLUTION
1	99.999	±DC MV	1 UV						
2	.99999	±DC V	10 UV	±%	.00001%	K OHM	.01 OHM		
3	9.9999	±DC V	100 UV	±%	.0001%	K OHM	.1 OHM	AC V	1 MV
4	99.999	±DC V	1 MV	±%	.001%	K OHM	1 OHM	AC V	10 MV
5	999.99	±DC V	10 MV			K OHM	10 OHMS	AC V	100 MV
6	9999.9					K OHM	100 OHMS		

DC VOLTS

FULL SCALE RANGES: ±99.999 MV/.99999V/9.9999V/ 99.999V/999.99 volts DC.

RANGING: Automatic and manual.

POLARITY: Automatic.

ACCURACY: ±(0.01% of reading, .001% of full scale) on 9.9999/99.999 and 999.99-volt ranges.

NOTE: Internal preamp is used for 99.999-MV and .99999-V ranges. It has a gain accuracy of ±0.01% of full scale plus short term drift of 3 microvolts, and long term drift of 30 microvolts per week referred to input on the 99.999-MV range. Zero adjust is located on the front panel.

COMMON MODE REJECTION: 80 DB @ 60 CPS, without filter.
120 DB @ 60 CPS, with filter.

INPUT RESISTANCE: 1000 megohms minimum on two lowest ranges; 10 megohms on upper three ranges.

SPEED: Bit Rate - 40 steps per second, tracking meter.

FLOATING INPUT: Signal-to-case potentials up to 500 volts are tolerable.

AC VOLTS

RESOLUTION: 1 MV on 10V range.

FULL SCALE: 9.999/99.99/999.9 volts.

RANGING: Automatic and manual.

FREQUENCY RANGE: 50 CPS - 10 KC.

ACCURACY: ±0.05% of reading, ±0.05% of range in use.

INPUT IMPEDANCE: 1 megohm shunted by 100 PF.

OHMS

INPUT: Four-wire input circuit.

FULL SCALE: .99999/9.9999/9.999/999.99 and 9999.9K ohms.

RANGING: Automatic and manual.

ACCURACY: ±.01± of reading ±0.01% of range in use.

SETTLING TIME: Proportional to resistance being measured. 6-second maximum for 1 megohm to within 0.01% of final value.

DC RATIO

FULL SCALE RANGES: .99999/9.9999/99.999 percent.

RANGING: Automatic and manual.

POLARITY: Automatic.

ACCURACY: ±0.01% of reading ±.001% of full scale.

REFERENCE INPUT: ±10 volts DC ±20%.

EXTERNAL REFERENCE INPUT RESISTANCE: 100,000 ohms.

INPUT RESISTANCE: 1000 megohms at balance on 99.999% range; 100 megohms minimum on .99999 and 9.9999% ranges.

DIMENSIONS: 19 IN. wide x 19-1/16 IN. deep x 5-1/2 IN. high.

WEIGHT: 35 LBS.

POWER: 115/220 volts, 50-60 CPS, approximately 80W maximum.

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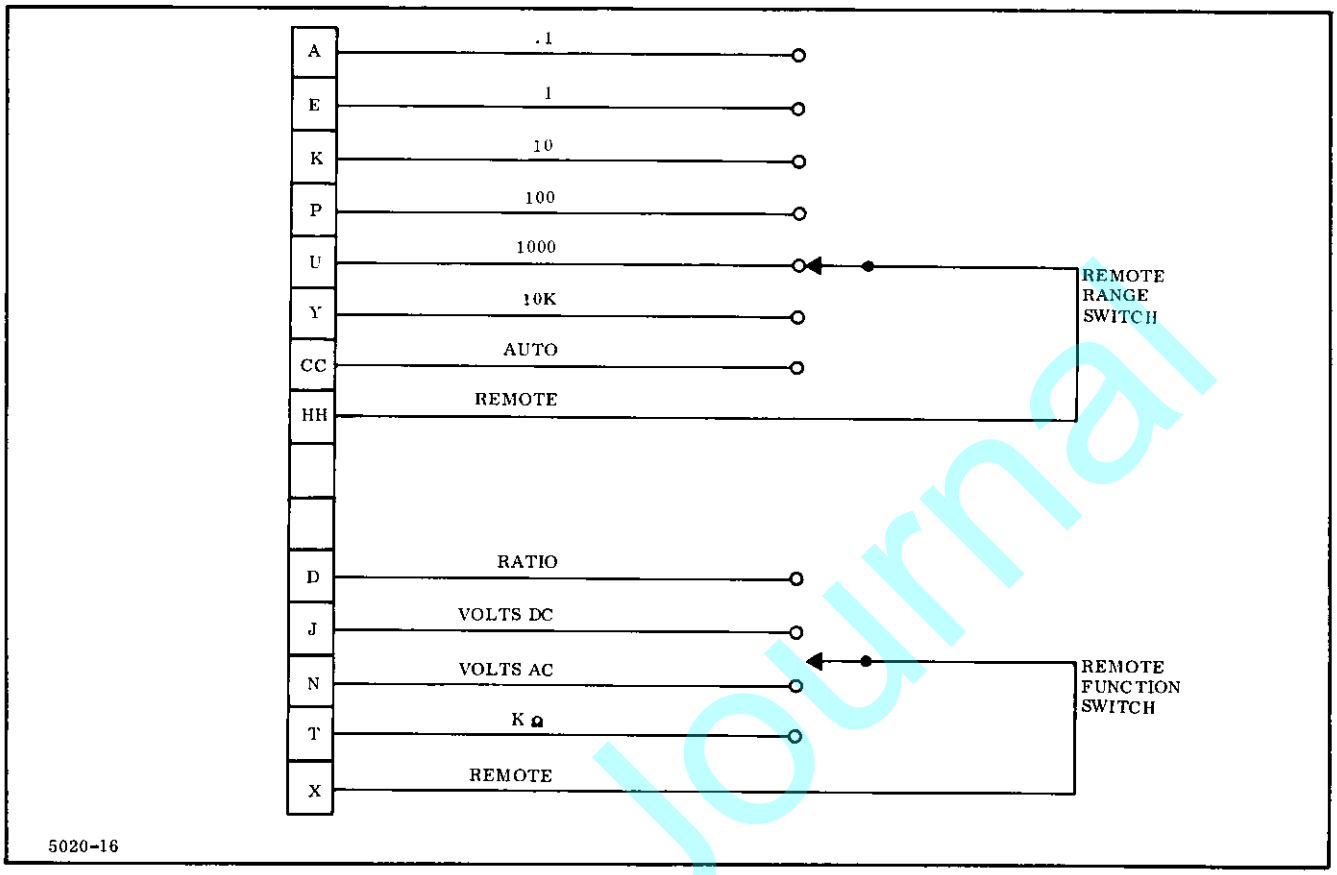

Figure 1-2. Remote Control Connections

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SECTION II

INSTALLATION AND OPERATION

UNPACKING

The instrument is shipped in a two-piece polystyrene-bead container. Cut the tape between the container halves and open. If damage is seen, promptly notify the carrier. No packing materials are used inside of the instrument and it is ready for use when taken out of the shipping container. It is suggested that the container be saved if the instrument is to be stored or shipped.

POWER SOURCE

The instrument is usually supplied for operation from 115-volt, 50-60 cycle, single phase power sources. However, the instrument will operate from 220-230-volt, 50-60 cycle, single phase sources if the two primaries of the power transformer are wired in series instead of parallel. The Serial Number tag at the rear of the instrument indicates the correct power source if other than 115 volts.

FUSING

The instrument is protected by a 3AG two-ampere slo-blo fuse which is located in an extractor post on the rear panel. When a 220-230-volt power source is to be used (and the power transformer primary rewired as indicated above), it is recommended that a one-ampere fuse be used to provide maximum protection. Keep in mind that the cooling fan is rated at 115 volts AC and must be paralleled with one winding of the power transformer pin connections when adapting the instrument to 230-volt operation.

POWER GROUNDING

The third pin of the power plug grounds the outer chassis of the instrument (figure 2-1). The internal guard shield box has no connection with power ground.

CABLES

The instrument is supplied with two input cables. Cable 15005-445 is for the measurement of voltage and resistance values and cable 5124 is for the measurement of ratio. See figures 2-2 and 2-3 for connection information.

CONTROLS

The power switch is provided to supply to and remove a current from the instrument and to allow a warm-up position (STANDBY). The power switch also provides three positions (AUTO, CONT, MANUAL) for use if the optional print-out capability is desired. If the print-out capability is not elected, these positions are locked out.

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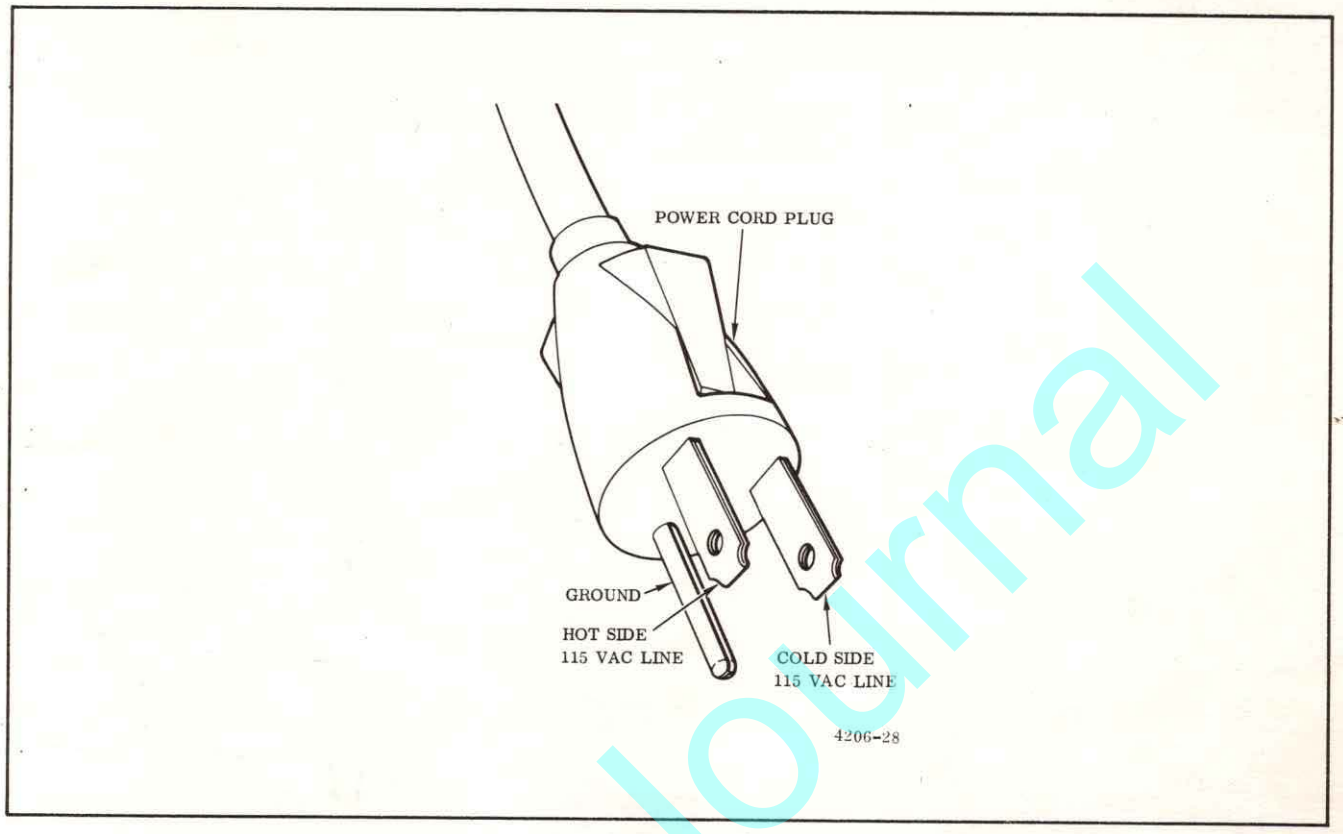

Figure 2-1. Power-plug Pin Coding

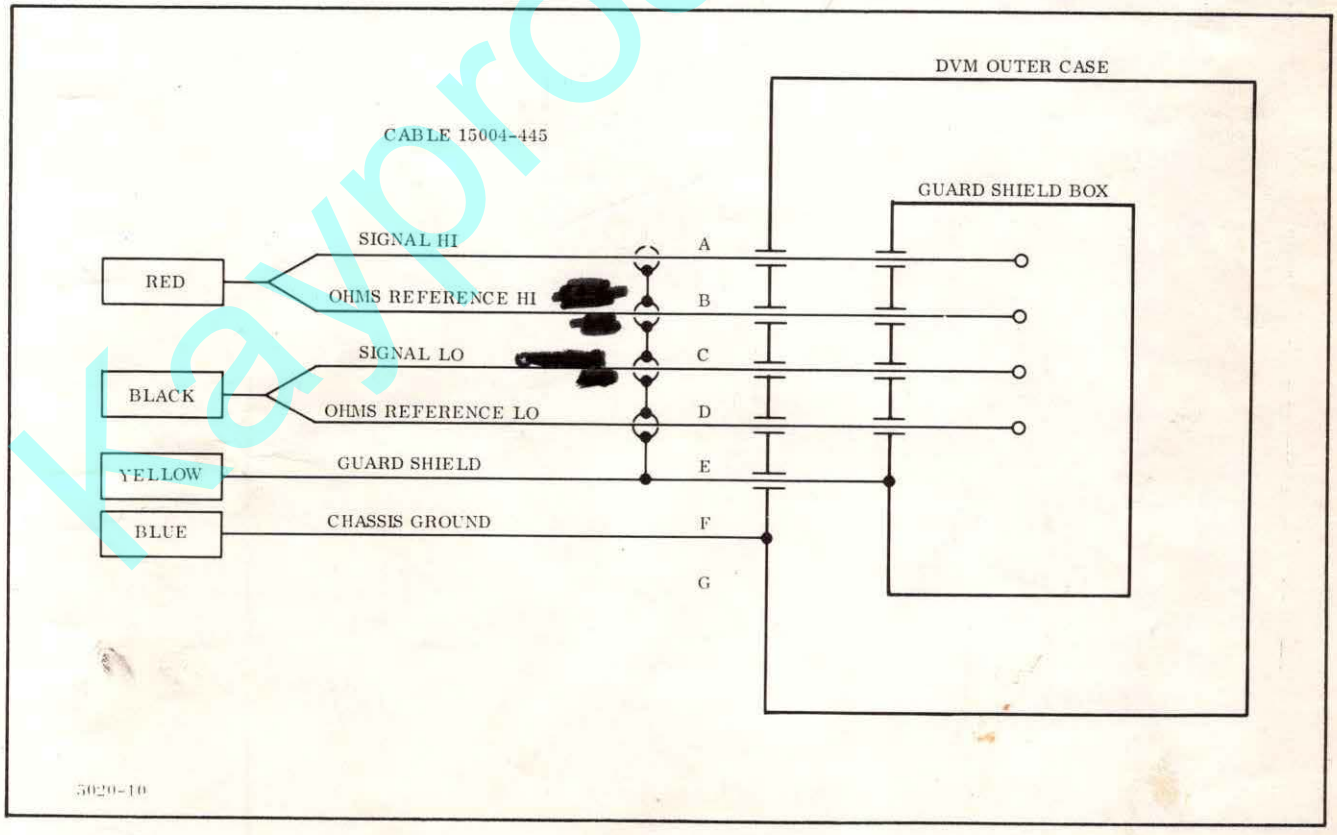

Figure 2-2. Input Connections (J2)

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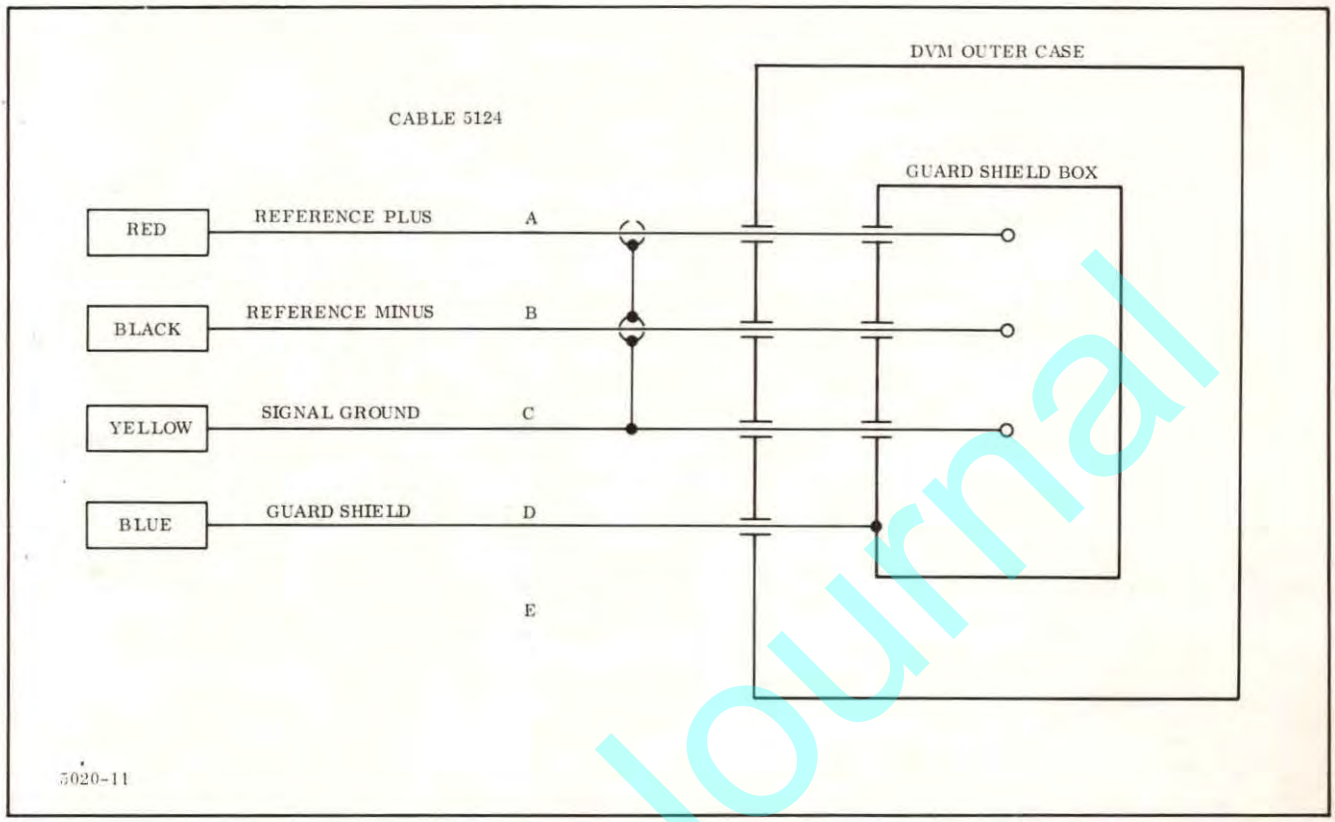

Figure 2-3. External Reference Connections (J3)

The SENS. control is provided to decrease sensitivity for noisy signals.

The MV ZERO ADJ. control is provided to permit a fine adjustment when calibrating in the millivolt range.

The FILTER switch is provided to engage or remove the filter application.

WARNING

If the FILTER switch is placed in the IN position, do not disconnect voltmeter input leads from voltage source when measuring in the 100V to 1000V range. The filter capacitors will remain charged to these dangerous levels for a considerable length of time if the input is opened. The Digital Voltmeter should be ranged down to the basic range after measuring high voltages or switched to filter OUT before being disconnected from the source.

The RANGE switch is provided to allow the selection of a specific range of measurement desired. This switch also provides an AUTO position for fully automatic ranging, and a REMOTE position for range control from a remote switching device. If the remote switching capability is not elected, this position is locked out.

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CAUTION

In order to prevent damage to relays in the Model 5020, the input voltage should never exceed 100 volts when measuring volts DC in the AUTO ranging mode and with the DVM in .1 of 1.0V range initially. To measure volts DC in excess of 100 volts, place the RANGE switch in the 1000 VDC range.

The FUNCTION switch is provided to allow the selection of ratio (%R), volts DC (DC), volts AC (AC), or ohms (KΩ) measurement. This switch also provides a REMOTE position for function control from a remote switching device. If the remote switching capability is not elected, this position is locked out.

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SECTION III

CALIBRATION

When a Model 5020 Digital Multi-Function Meter is not making readings within specifications, it is time for calibration, repair or both. In the calibration instructions provided in this section, it is assumed that the instrument is in good working order and only requires calibration. If any components are defective, it may be difficult, if not impossible, to calibrate the instrument properly.

The calibration procedure is divided into six distinct areas: power supply adjustment, volts DC calibration, ratio adjustment, pre-amplifier calibration, volts AC calibration, and ohms calibration. See figure 3-1 for location of all major assemblies and zero adjust potentiometer.

EQUIPMENT REQUIRED

1. A Triplett Model 630-NA voltmeter or equivalent.
2. A Tektronix Model 502 oscilloscope or equivalent.
3. A bank of nine standard cells: NLS EMF Standard No. 3006.
4. A DC High Voltage Supply and Calibrator, NLS Model 3021.
5. A Ratio Test Fixture, NLS Model 3022.
6. A Dekavider, Model DV-411 Electronic Scientific Industries.
7. Five ohms standards, each having ±0.01% accuracy. The ohmic values required are approximately 0.9K, 9K, 90K, 900K, and 9000K. The resistors must be carefully shielded against any stray pick-up or they can couple noise into the instrument and cause an erroneous standardization setting.
8. An Audio Voltage Standard, Holt Model AVS 323A, or equivalent.
9. Input Cable, NLS No. 15004-445.
10. External Reference Cable, NLS No. 5124.
11. An Interconnecting Cable, Ratio Test Fixture to DC High Voltage Supply and Calibrator, NLS No. 3022-008.
12. An Interconnecting Cable, Ratio Test Fixture to DV-411 Dekavider, NLS No. 3022-33.
13. Two Extension Boards, NLS No. 1009-22.

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Figure 3-1. Top View, Showing Major Assemblies and Zero Adjust Potentiometer

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GRND YELLOW LEAD FOR STABILITY

INITIAL PREPARATION

1. Plug instrument power cord into 115-volt power source and turn power switch to STANDBY. Allow a 60-minute warm-up period.

2. Interconnect Ratio Test Fixture, DC High Voltage Supply and Calibrator and DV-411 Dekavider as shown in figure 3-2.

3. Plug DC High Voltage Supply and Calibrator power cord into 115-volt power source and turn power switch to STBY. Allow a 30-minute warm-up period.

POWER SUPPLY ADJUSTMENT

1. Remove inner and outer cover of instrument.

2. Remove power supply assembly from the instrument.

3. Insert extension boards into power supply connectors J11 and J12 on main board assembly.

4. Mount power supply assembly on top of extension boards by inserting power supply board pins into extension boards. Use care to ensure proper pin alignment.

5. Connect a Triplett Model 630-NA Voltmeter or equivalent between the +12V and +24V outputs, pin 9 and pin 11 of P1 (figure 3-3).

6. Set test meter range switch to 60V and scale switch to V/2.

7. Adjust R17 (figure 3-3) on power supply assembly until test meter reads +12 VDC (+1V, -0V).

8. Connect test meter between ground and the +12V output at P2-9 and P1-9 (figure 3-3).

9. Adjust R16 (figure 3-3) on power supply assembly until test meter reads +12 VDC.

10. Remove power supply assembly from extension boards.

11. Remove extension boards from main board assembly.

12. Replace power supply assembly.

13. Replace inner cover (one screw only).

VOLTS DC CALIBRATION (10-, 100-, AND 1000-VOLT RANGES) D.C. TOL. .01%

Gain Adjustment

1. Ensure that a minimum period of 60 minutes has been allowed for instrument warm-up.

2. Connect instrument to Ratio Test Fixture as shown in figure 3-2. Place FILTER control in the IN position.

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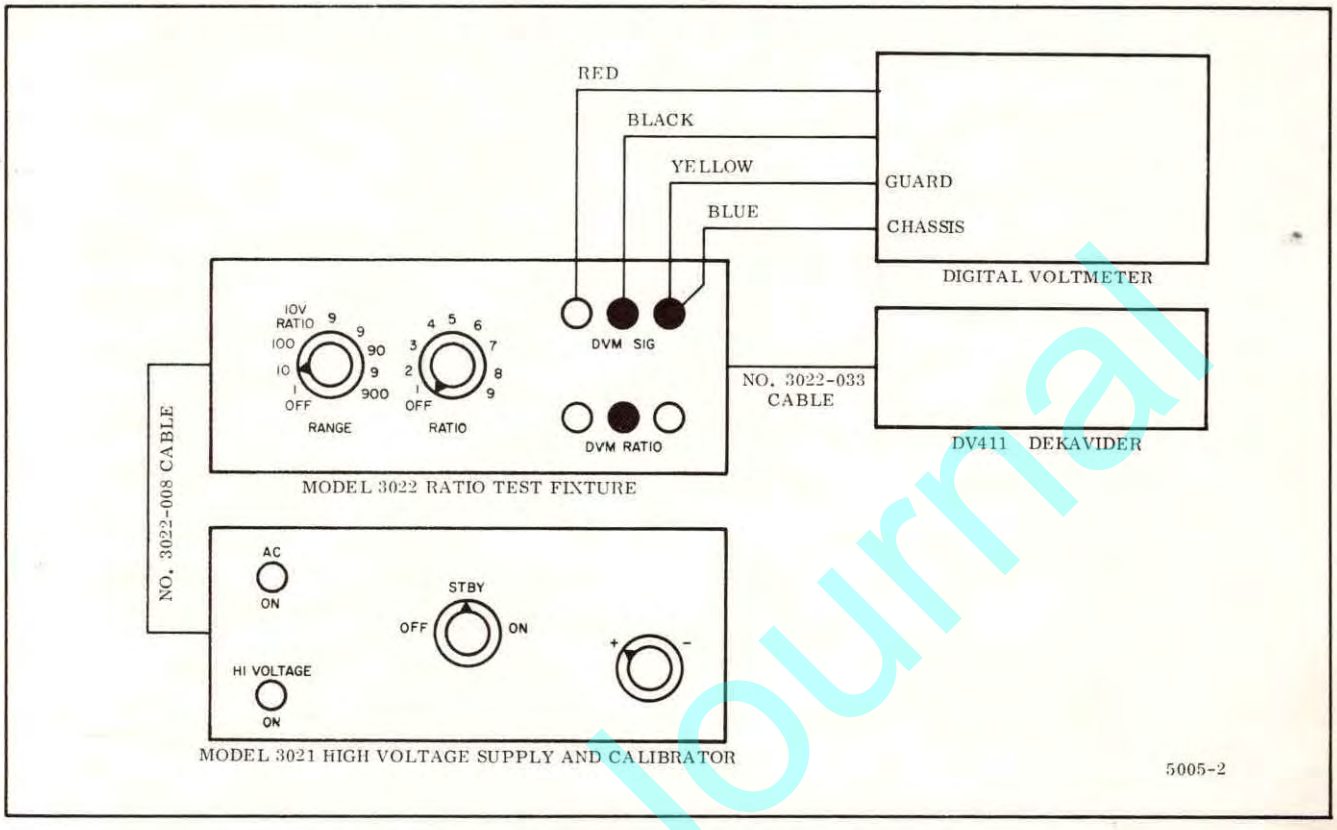
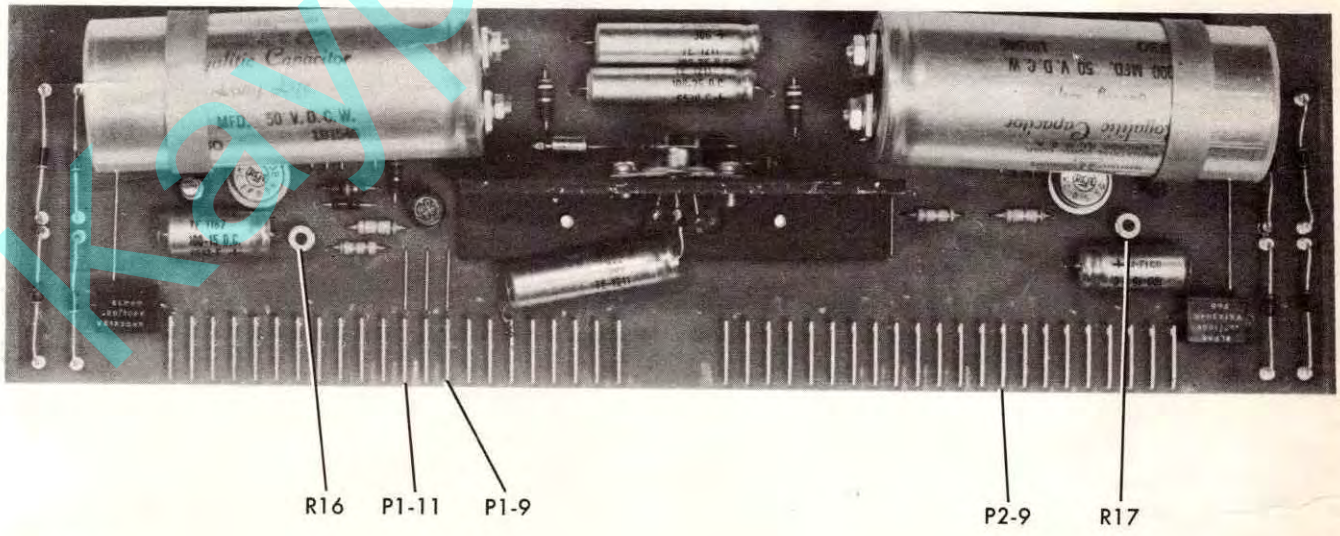


Figure 3-2. Range Calibration Cable Connections



5020-3

Figure 3-3. Power Supply Adjustment and Test Points

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3. On Ratio Test Fixture, turn RATIO switch to OFF and RANGE switch to 10.

4. Turn the instrument power switch to ON. Turn DC High Voltage Supply and Calibrator power switch to ON.

5. Set all Dekavider dials to zero. All instrument readout windows should read zero.

6. Using the least significant dial of the Dekavider, increase the signal voltage to the instrument and slowly decrease it. The instrument should count down one digit at a time. If not, error amplifier gain is too low.

7. Increase gain by turning gain potentiometer R36 (figure 3-4) on amplifier assembly in a clockwise direction. Slowly decrease signal input to the instrument. Gain is correct when the DVM barely counts down one digit at a time. The instrument how has a 100 microvolt sensitivity. If gain is too high - least significant digit unstable or rolling - R36 should be turned counterclockwise to reduce gain. Keep instrument front panel sensitivity control fully clockwise during this adjustment.

WARNING

If the FILTER switch is placed in the IN position, do not disconnect voltmeter input leads from voltage source when measuring in the 100V to 1000V range. The filter capacitors will remain charged to these dangerous levels for a considerable length of time if the input is opened. The instrument should be ranged down to the basic range or switched to filter OUT before being disconnected from the source.

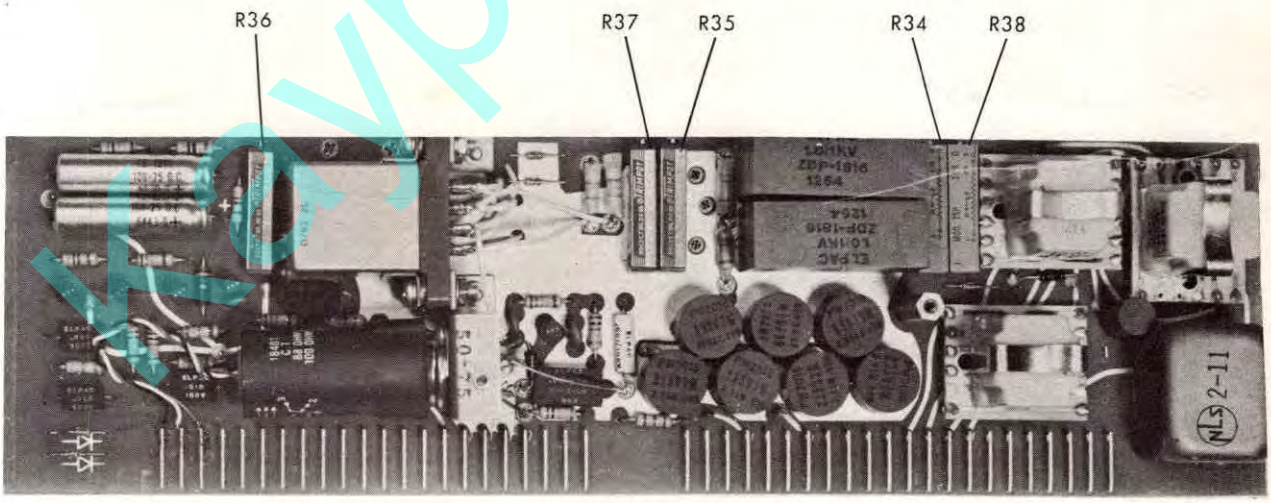

Figure 3-4. Amplifier Adjustment Points

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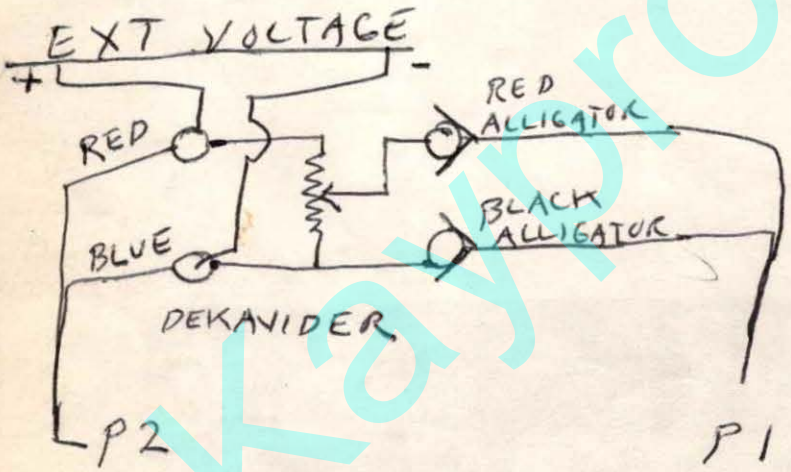
RATIO CHECK



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Basic Accuracy Calibration

1. Disconnect DVM signal input leads from Ratio Test Fixture, and connect to standard cell bank as shown in figure 3-5.

2. The instrument should display the carded value of the nine standard cells, e.g. 9.1651V; if not, adjust coarse and fine adjustment potentiometers R38 and R34 (figure 3-4) until it does. The calibration is now set in the basic range of 10 VDC.

Range Calibration

1. Disconnect signal input leads from standard cell bank and reconnect to Ratio Test Fixture as before (figure 3-2).

2. Set RANGE switch on the Ratio Test Fixture to 9. Observe the reading on the 9.0000V range and Record. For discussion purposes, let us say that the reading was 9.1364.

3. Next, set RANGE switch to 90. Observe the reading. Meter should read 91.364. If not, adjust R37 (figure 3-4) until it does.

4. Next, set RANGE switch to 900. Observe the reading. Meter should read 913.64. If not, adjust R35 until it does.

Final Gain Check

1. Set all Dekavider dials to zero. Apply input signals to the instrument using the least significant dial on the Dekavider. Check gain as before, Step 5 under Gain Adjustment. Adjust gain to make instrument count down one digit at a time. Use only as much gain as needed to barely get one-digit steps as instrument counts down.

RATIO CHECK

1. Disconnect signal input leads from Ratio Test Fixture.

2. Connect external reference leads from instrument to Ratio Test Fixture as shown in figure 3-6.

3. Turn RANGE switch on Ratio Test Fixture to 10V RATIO and RATIO switch to 1 through 9. Instrument reading should agree with carded values.

PRE-AMPLIFIER CALIBRATION

1. Ensure that a minimum period of 60 minutes has been allowed for instrument warm-up.

2. Connect leads of a Tektronix Model 502 oscilloscope or equivalent to top lead of C6 and ground as shown in figure 3-7.

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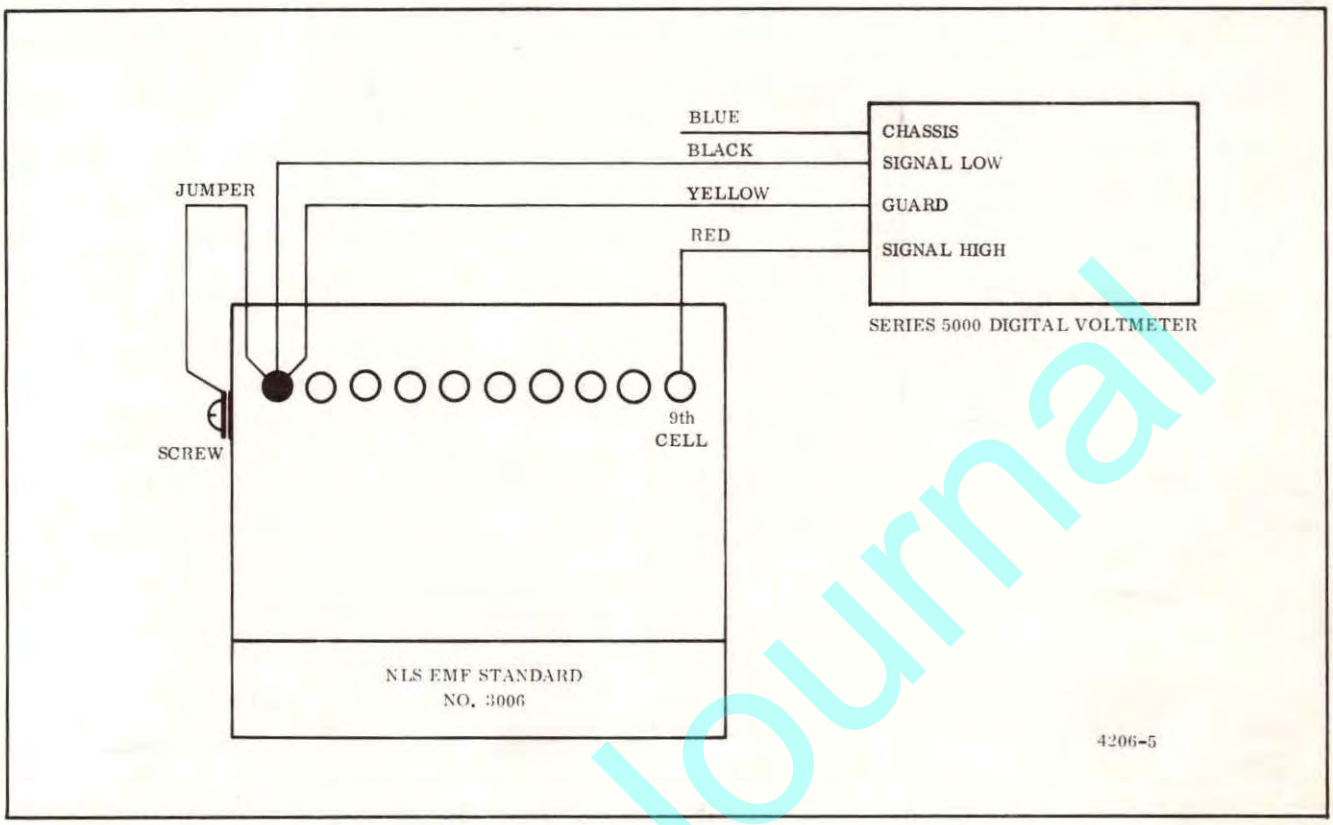

Figure 3-5. Basic Accuracy Calibration Cable Connections

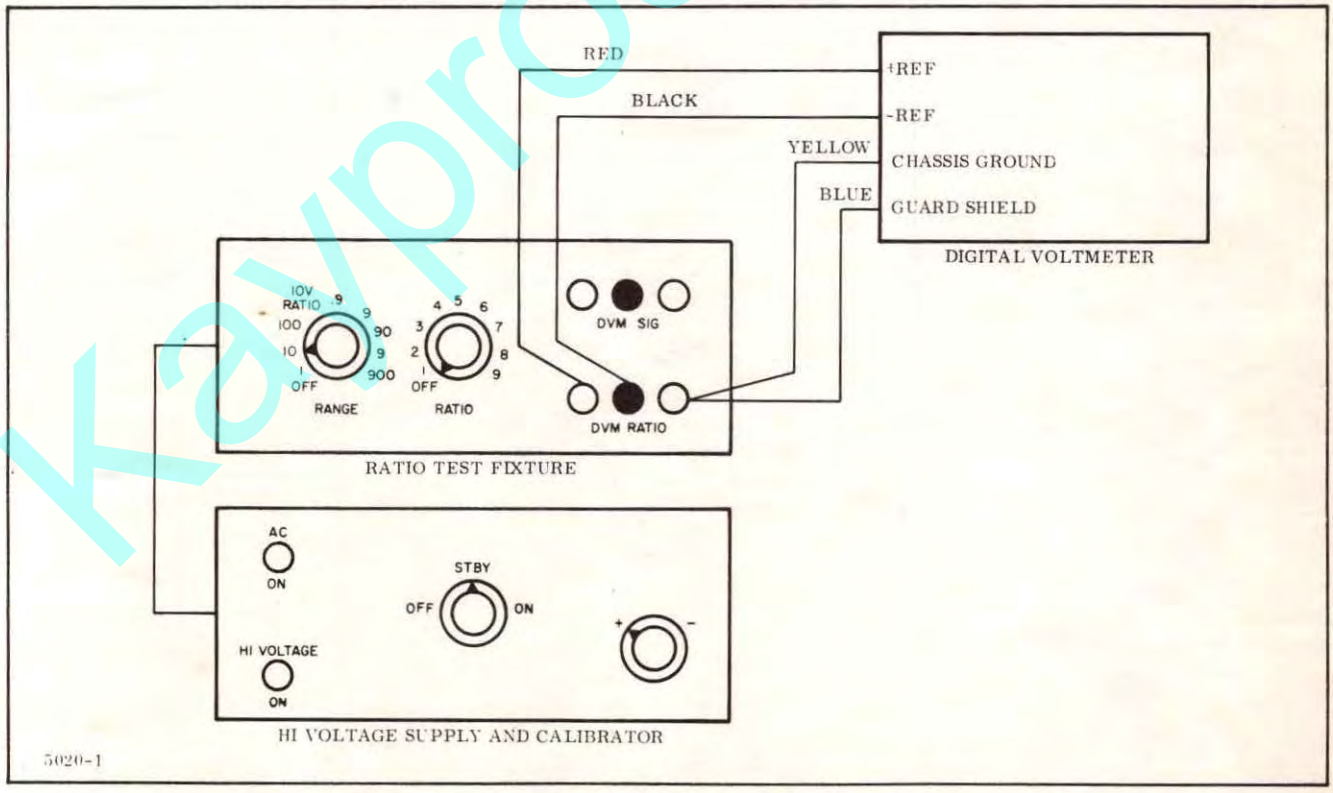

Figure 3-6. Ratio Calibration Cable Connections

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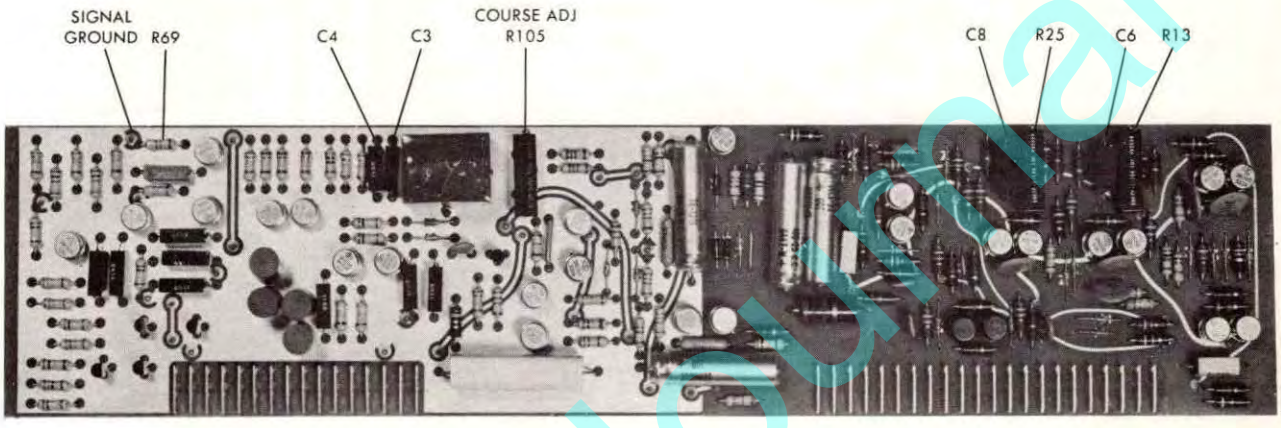
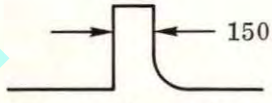


5020-5

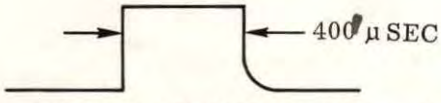
Figure 3-7. Pre-amplifier Adjustments and Test Points

3. Adjust potentiometer R13 (figure 3-7) until a square wave having a duration of 150 microseconds appears on oscilloscope.



4. Connect leads of oscilloscope to top lead of C8 and ground as shown in figure 3-7.

5. Adjust potentiometer R25 (figure 3-7) until a square wave having a duration of 400 microseconds appears on oscilloscope.



6. Place FUNCTION switch in DC position and RANGE switch in .1 position.

7. Short input leads (red and black clips together and yellow and blue banana pins together).

8. Connect leads of oscilloscope to top lead of either C3 or C4 and ground as shown in figure 3-7.

9. Adjust potentiometer R105 (figure 3-7) for zero error (waveform should appear as AT BALANCE in figure 3-8).

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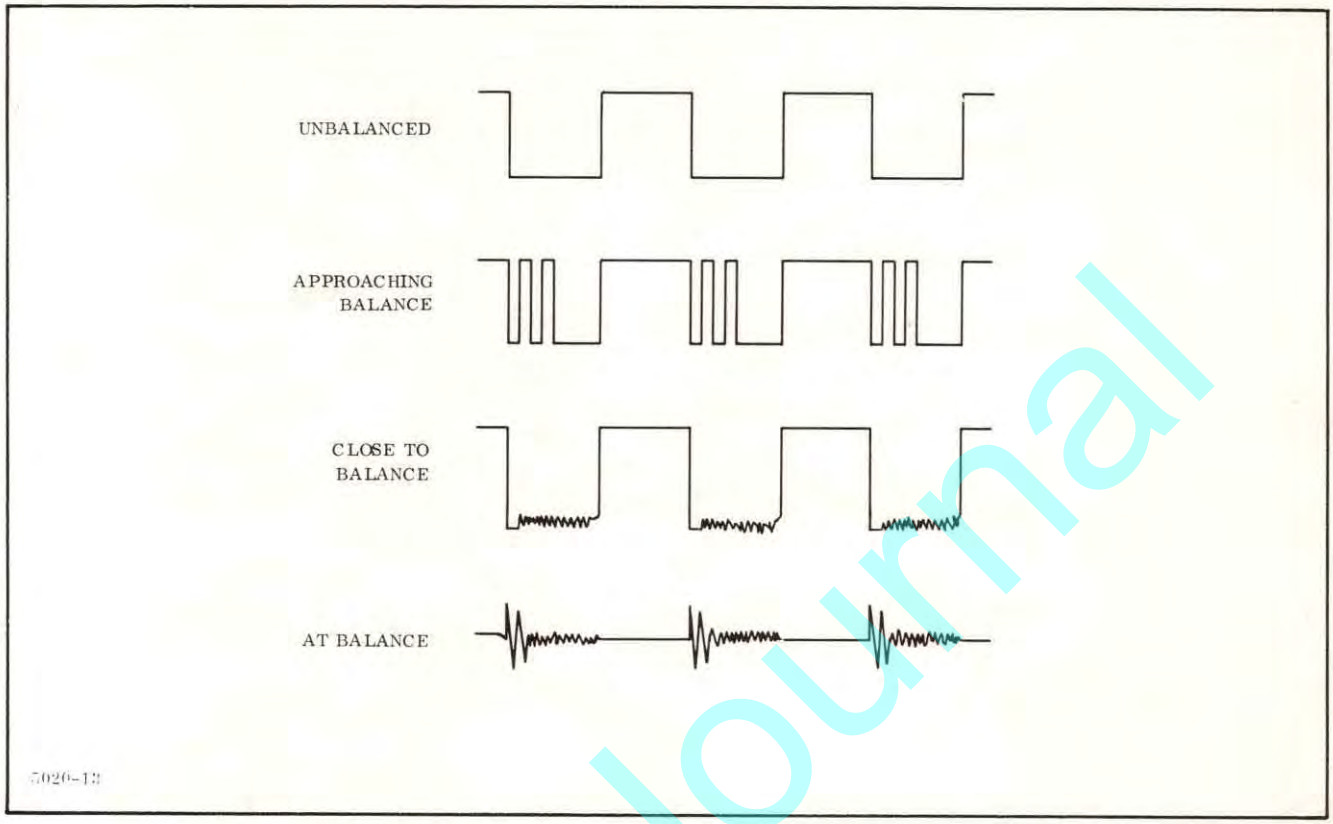

Figure 3-8. Typical Waveforms to Obtain Zero Error

10. With waveform appearing as set forth in step 8, readout of instrument should display within 300 digits of all zeros. Place MV ZERO ADJ. control on front panel in center of its range (calibration mark on knob should point straight up).

11. Again adjust potentiometer R105 to bring readout display as close as possible to all zeros.

12. Re-adjust MV ZERO ADJ. to bring readout display to all zeros.

13. Disconnect oscilloscope leads.

Range Calibration (.1V and 1V)

1. Connect instrument to Ratio Test Fixture as shown in figure 3-2.

2. Replace inner cover.

3. Ensure that FUNCTION switch remains in DC position and RANGE switch in .1 position.

4. Apply 90.000 MV and adjust R12 (figure 3-9) until readout displays 90.000 MV.

5. Place RANGE switch in 1 position. Apply .90000V and adjust R17 (figure 3-9) until readout displays .90000V.

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A.C. TOL. .05%

6. Disconnect instrument from Dekavider.

AC CALIBRATION

1. Ensure that a minimum period of 60 minutes has been allowed for instrument warm-up.

2. Remove inner cover.

3. Remove AC attenuator and converter assembly.

4. Insert extension boards into AC attenuator and converter assembly connectors J35 and J36 on main board assembly.

5. Mount AC attenuator and converter assembly on top of extension boards by inserting AC attenuator and converter board pins into extension boards. Use care to ensure proper pin alignment.

6. Short all four input leads together.

7. Place FUNCTION switch in AC position and RANGE switch in 10 position.

8. Adjust potentiometer R3 (figure 3-1) until readout displays all zeros. If readout remains stable with all zeros (digits not rolling), perform steps 23 and 24. If readout remains stable at 9.0000V (step 24), proceed to step 25. If instrument is not stable on all zeros, proceed to step 9. If instrument is stable on all zeros but not stable on 9.0000V, repeat step 6 and then proceed to step 9.

9. Short P2-13 to P2-10 (figure 3-10) with a clip lead.

10. Place FUNCTION switch in DC position.

11. Connect a 10K resistor between output capacitor (lead of C9 as shown in figure 3-10) and signal ground.

12. Adjust DC level potentiometer R53 (figure 3-10) until readout displays 6.0000V.

13. Connect red and black input clips to lead of R32 and signal ground (figure 3-10).

14. Adjust DC balance potentiometer R52 (figure 3-10) until readout displays approximately 5.0000V (±0.01V).

15. Connect red and black input clips to lead of R34 and signal ground (figure 3-10).

16. Repeat step 14 above.

17. It may be necessary to repeat steps 13 through 16 several times to attain the correct reading from both test points.

NOTE: Measured values should be within 0.01V of each other and approximately 5V (±1V).

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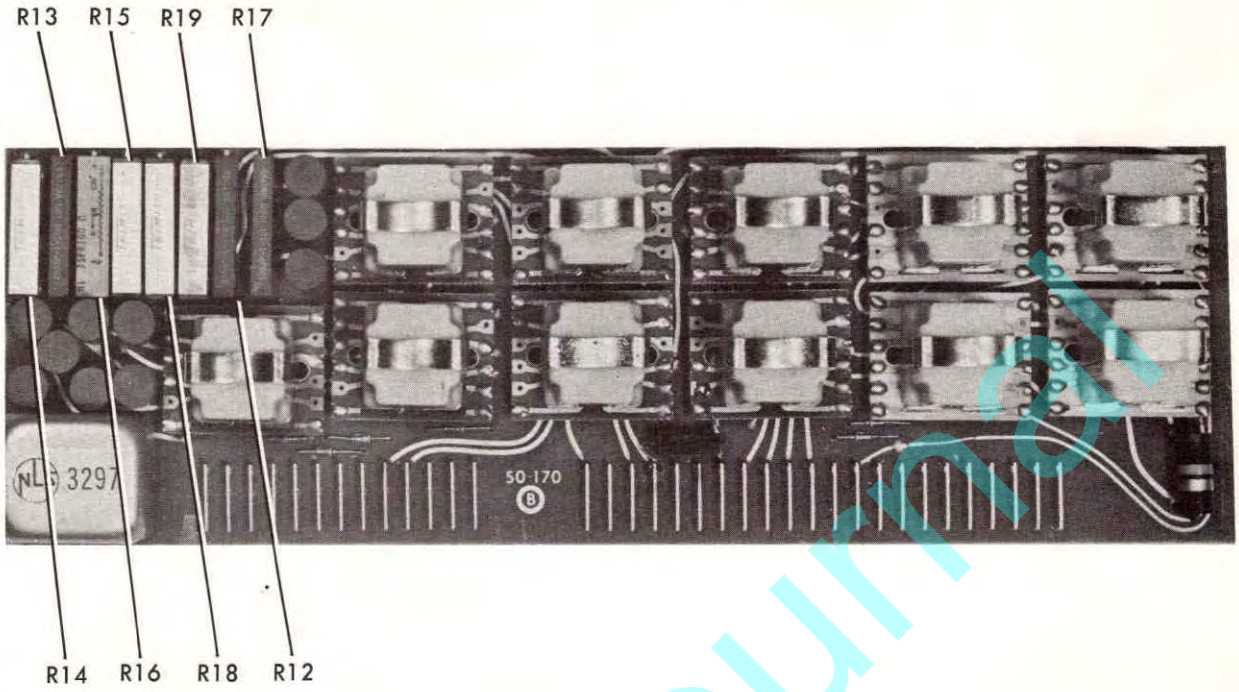
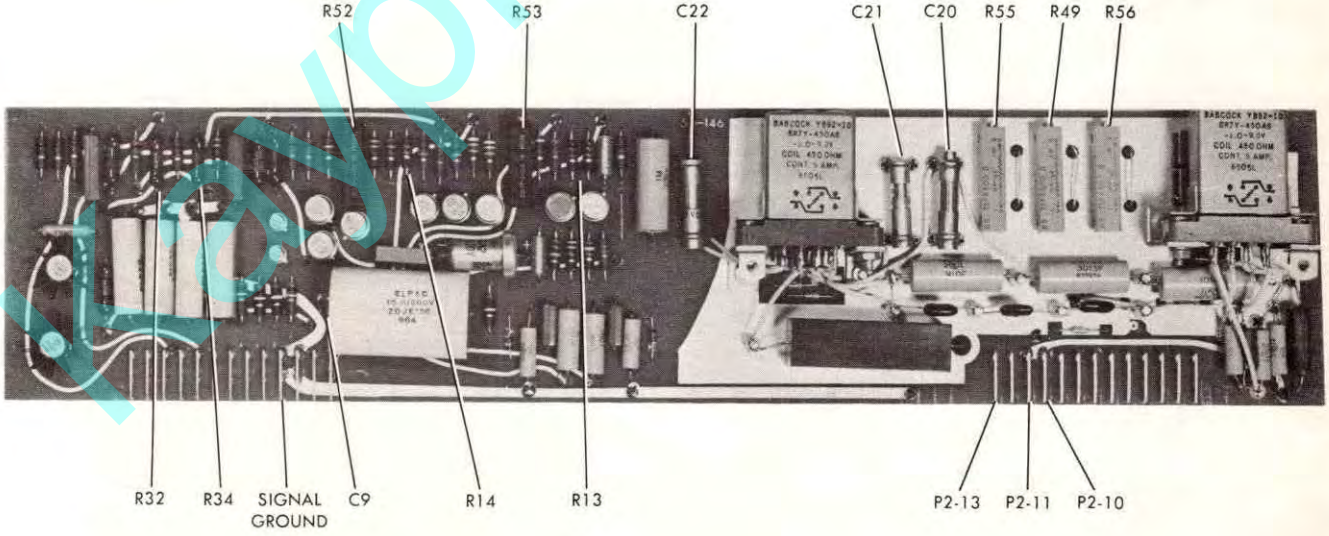


Figure 3-9. Input Switching Adjustment Points



5020-6

Figure 3-10. AC Attenuator and Converter Adjustment and Test Points

A.C. TOL. .05 %

18. Repeat steps 11 thru 16 until reading from each test points is correct.

19. If required values set forth in steps 11 through 18 cannot be attained, connect red and black input clips to lead of R14 and ground (figure 3-10) and also to lead of R13 Signal ground (figure 3-10). Each measurement should display -2.1000V (±1.5V) in readout.

20. If measurement from lead of R13 and ground is out of tolerance, follow instructions in note 4 on schematic 50-148.

21. When DC balance and level adjustments attain proper values, disconnect 10K resistor from lead of C9.

22. Repeat steps 6 through 8.

23. Connect input leads to an Audio Voltage Standard, Holt Model 323A or equivalent, as shown in figure 3-11.

24. With instrument remaining in 10-volt range, AC, apply 9.0000V, 50 CPS and adjust feedback gain potentiometer, R36 (figure 3-10) until readout displays 9.0000V.

25. Apply 9.0000V, 10KC and adjust 10V range trimmer capacitor, C22 (figure 3-10) until readout displays 9.0000V.

26. Repeat steps 24 and 25.

27. Apply 9.0000V, 400 CPS. Observe readout display and record.

28. Apply 9.0000V, 1KC. Observe readout display and record.

29. Continue to perform steps 24, 27 and 28 until errors at 400 CPS and 1KC are compensated for. See figure 3-12.

30. Apply 90.000V, 50 CPS and adjust feedback gain potentiometer, R49 (figure 3-10) until readout displays 90.000V.

31. Apply 90.000V, 10KC and adjust 100V range trimmer capacitor, C21 (figure 3-10) until readout displays 90.000V.

32. Repeat steps 30 and 31.

33. Apply 90.000V, 400 CPS. Observe readout display and record.

34. Apply 90.000V, 1KC. Observe readout display and record.

35. Continue to perform steps 30, 33 and 34 until errors at 400 CPS and 1 KC are compensated for. See figure 3-12.

36. Apply 900.00V, 50 CPS and adjust feedback gain potentiometer, R55 (figure 3-10) until readout displays 900.00V.

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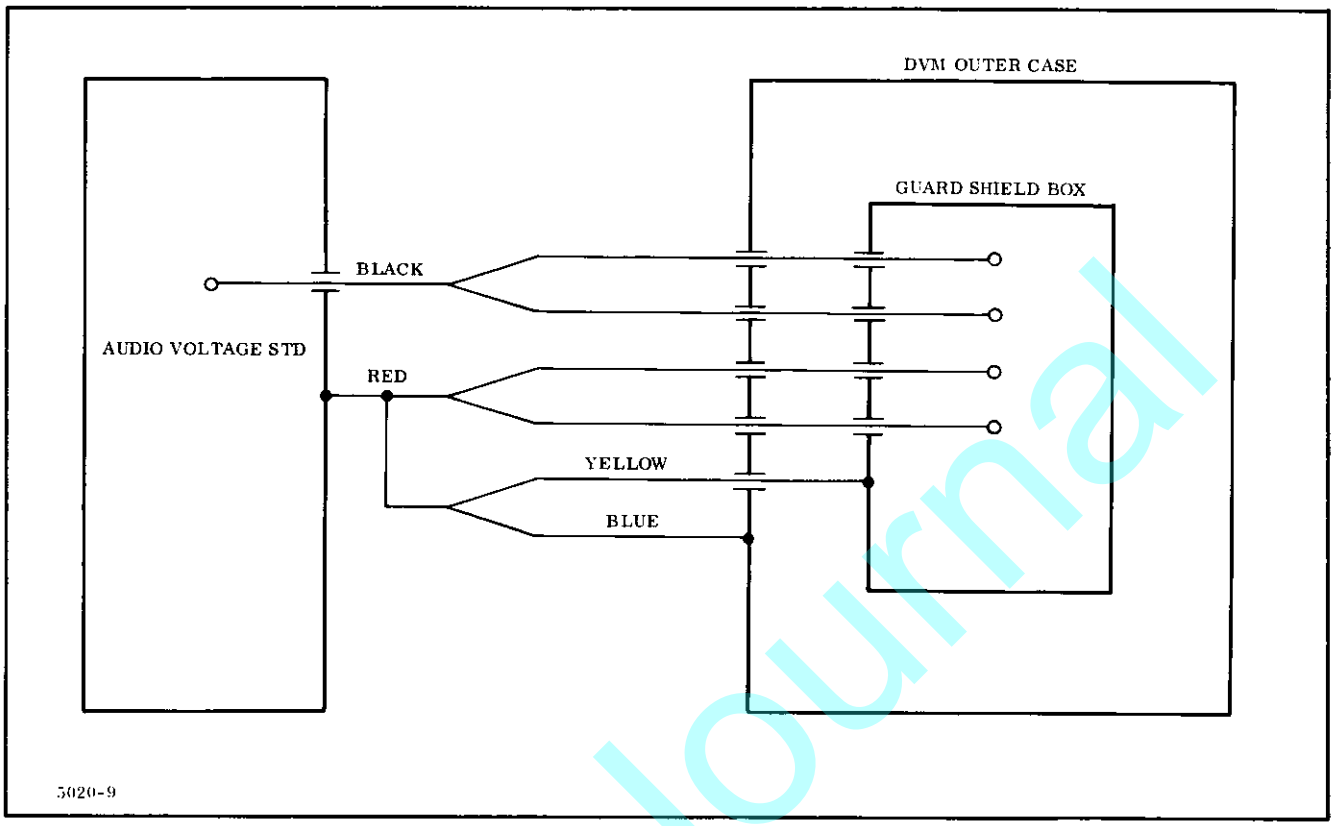

Figure 3-11. AC Calibration Cable Connections

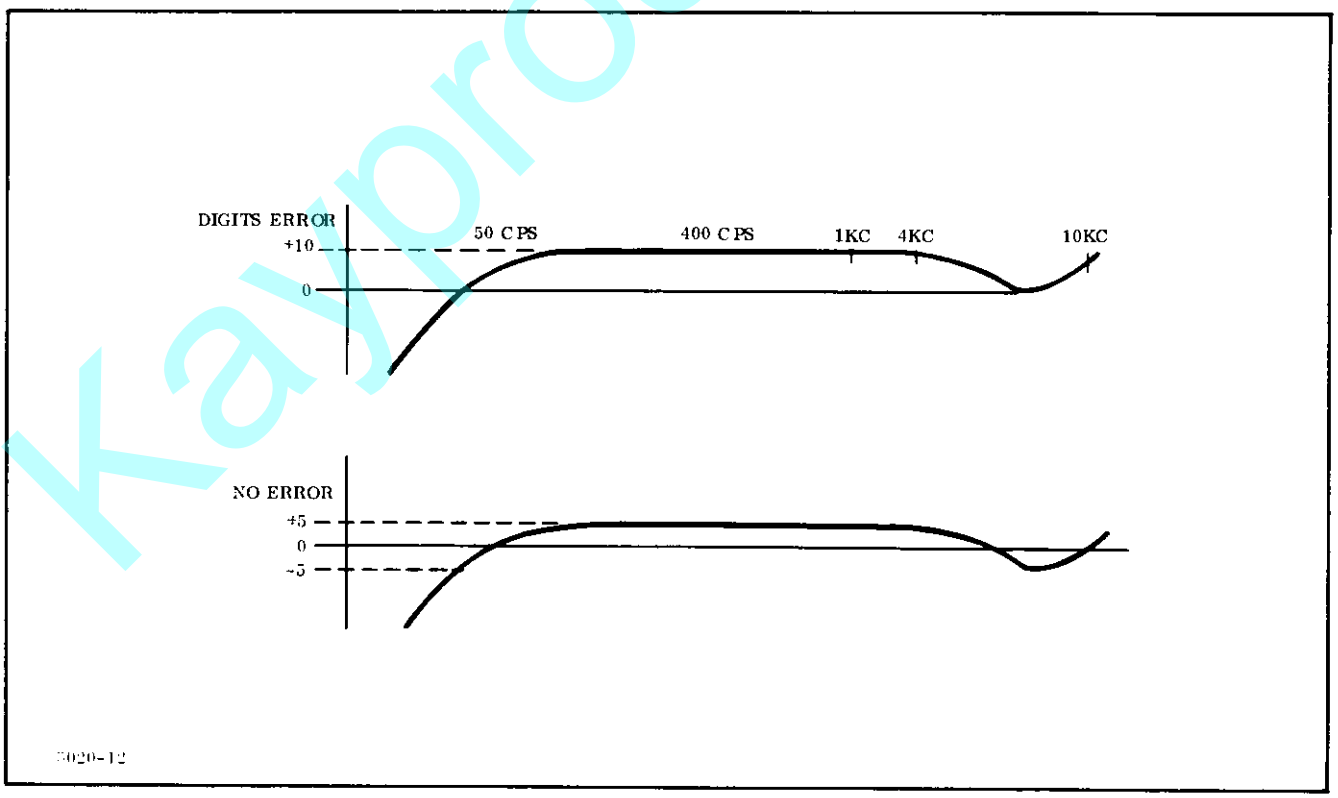

Figure 3-12. Error Compensating Diagram

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37. Apply 900.00V, 10 KC and adjust 1000V range trimmer capacitor, C20 (figure 3-10) until readout displays 900.00V.

38. Repeat steps 36 and 37.

39. Apply 900.00V, 400 KC. Observe readout display and record.

40. Apply 900.00V, 1 KC. Observe readout display and record.

41. Continue to perform steps 36, 39 and 40 until errors at 400 CPS and 1 KC are compensated for. See figure 3-12.

42. Disconnect leads from Audio Voltage Standard.

43. Remove AC attenuator and converter assembly from extension boards.

44. Remove extension boards from main board assembly.

45. Replace AC attenuator and converter assembly in main board assembly.

46. Replace inner cover.

OHMS CALIBRATION

1. Ensure that a minimum period of 60 minutes has been allowed for instrument warm-up.

2. Connect input leads of instrument to an ohms standard accurate to ±0.01% (figure 3-13). The values required are called out in each calibrating step.

3. Place RANGE switch in 1K range.

NOTE

The 1K range is displayed on the front panel as the numeral 1 since the ohms ranges are in K ohms. Also, the numerals 10 and 100 represent the 10K and 100K ranges respectively and the 1K and 10K displays represent the 1 MEG and 10 MEG ranges respectively.

Apply approximately .90000K ohms and adjust coarse and fine potentiometers on input switching board (R14 and R13, figure 3-9) respectively until readout agrees with standard. Once instrument is calibrated in 1K range, do not again adjust R14 or R13.

4. Place RANGE switch in 10K range. Apply approximately 9.0000K ohms and adjust 10K potentiometer on input switching board (R16, figure 3-9) until readout agrees with standard.

5. Place RANGE switch in 100K range. Apply approximately 90.000K ohms and adjust 100K potentiometer on input switching board (R15, figure 3-9) until readout agrees with standard.

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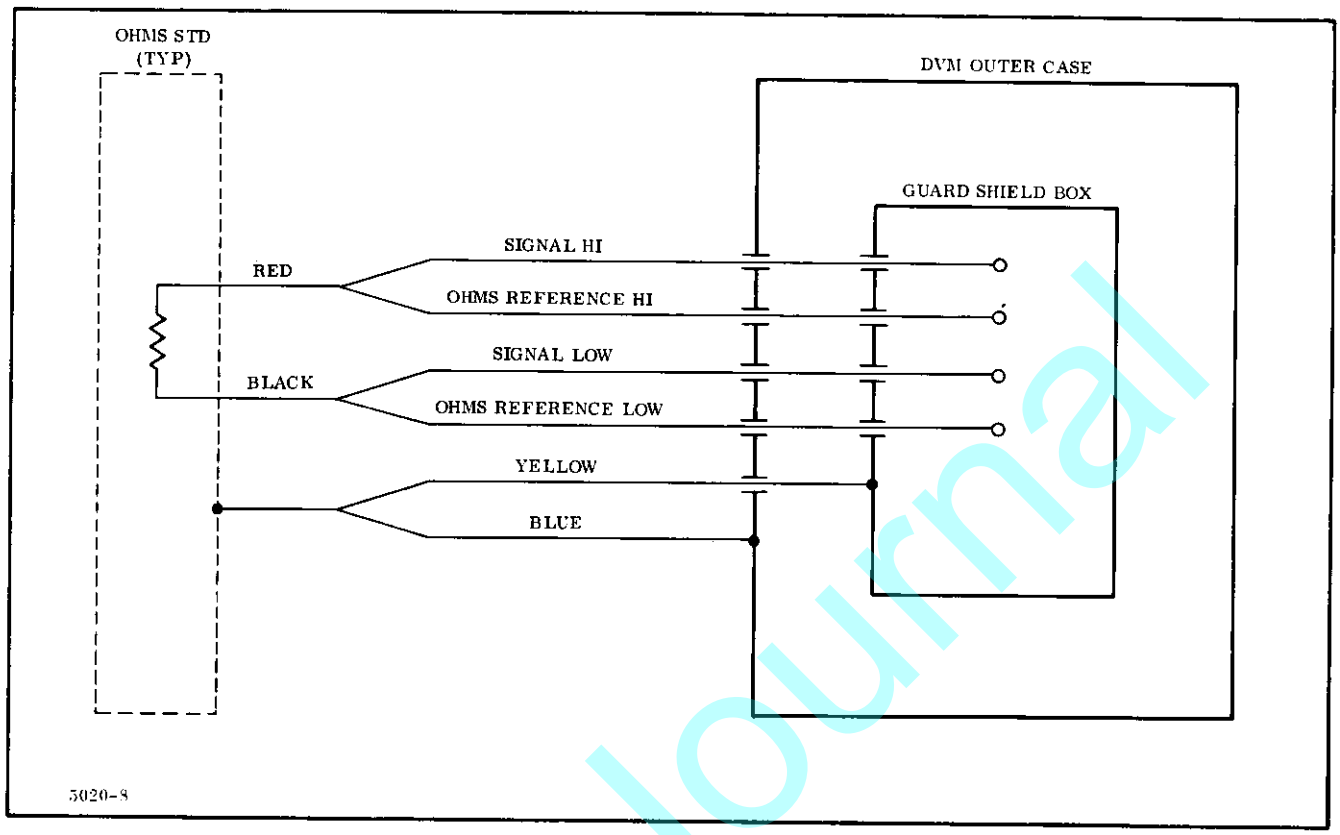

Figure 3-13. Ohms Calibration Cable Connections

6. Place RANGE switch in 1 MEG range. Apply approximately 900.00K ohms and adjust 1 MEG potentiometer on input switching board (R18, figure 3-9) until readout agrees with standard.

7. Place RANGE switch in 10 MEG range. Apply approximately 9000.0K ohms and adjust 10 MEG potentiometer on input switching board (R19, figure 3-9) until readout agrees with standard.

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CHAPTER IV

MAINTENANCE

If the instrument is not working properly, or if it cannot be calibrated according to instructions, service will be required.

EXTENSION BOARDS

During maintenance procedures, two 22-pin extension boards will be required to raise each plug-in module (only one board is required for the logic and pre-amp power supply assembly) so that pin contacts on the bottom of the circuit board become accessible for the measurement of voltages and the observation of wave forms. These boards, NLS part number 1009-22, may be ordered from any NLS representative or from the NLS Main Office in Del Mar, California.

GENERAL PROCEDURE

Before seeking out specific defective components, it is best to establish that the power supplies are working. Specifically, voltage checks should be made at the voltage output points of the power supplies as indicated on the schematic drawings. A simple 20,000 ohm-per-volt d'Arsonval type meter may be used for these measurements. The voltage measurements should indicate correct values ±15% when read on a voltmeter with a rated accuracy of ±13%. The outputs of the regulated power supplies cannot be accurately read by this method, but in practice the accuracy of their outputs need not be known; if a regulated power supply fails, it is most likely that the voltage error will be gross (or there will be no output at all) and therefore detectable with simple measuring instruments.

If a measured voltage appears to be at an improper value, the associated power supply components should be checked: if none of these are found to be defective, it will be necessary to proceed along the defective power path, checking wiring, connectors, printed circuitry, and finally components on the boards. An obvious way to make a speedy check is to replace suspected defective boards with known good ones.

It is suggested that the individual schematics be studied so as to better know what outputs may be expected at each function.

TROUBLESHOOTING

Table 4-1 lists specific types of malfunction. Note that any of dozens of components could fail and yet the symptom would be the same for all; there is no one component which can readily be singled out as a consistent offender. For this reason, the most useful approach to troubleshooting is to provide a list of possible types of failure and identify the plug-in board or circuit area most likely to contain the defective component.

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Table 4-1. Troubleshooting

SYMPTOM	PROBABLE CAUSE
Readout locks on 9 in a given decade	Decade assembly (relays)
Decimal lights are out or are incorrect	Logic assembly, readout
Multiple lights appear in one or more decades	Decade assembly
A particular digit fails to illuminate	Readout bulb
Readout is locked at 99999, or is unstable and seeks 99999 regardless of input	Amplifier assembly Logic Assembly
Instrument skips digits, or has "holes" in decades. Transfers and linearity are poor	Decade assembly (bridge resistors)
Readout shows only certain numbers in decades	Decade assembly (decode matrix)
Readout illumination is dim	Power supply assembly
Readout displays erroneous values which are somewhat proportional to the input	Amplifier assembly (range divider)
Readout display is consistently higher than the input	Amplifier assembly (reference)
Readout "sticks" on particular numbers	Decade assembly (relays)
With input shorted, polarity locks one way; machine locks at all nines or decimal point goes on and off	DC AMPLIFIER a. Zero adjust off b. Zero adjust transistor (Q25, pre-amplifier board) broken c. Output transistor (Q28 or Q29 pre-amplifier board) shorted)
Same as above except that zero adjust seems to switch polarity	Zero adjust transistor (Q25, pre-amplifier board) broken
At zero input level readout drifts + and - and is slow coming to final reading	AC AMPLIFIER a. Gain is low. Check output levels of each differential pair (Q13 thru Q22, pre-amplifier board). Should be the same within 1 or 2 volts b. Input capacitor filter (C8, C3 main board assembly) leaky

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Table 4-1. Troubleshooting (Continued)

SYMPTOM	PROBABLE CAUSE
Instrument will not calibrate on x10 or x100	Feedback resistor R107 or C5 and C6 across it (pre-amplifier board) malfunctioning
Instrument will not calibrate on x10 only	Resistor R87 or potentiometer R17 (input switching board) malfunctioning
Instrument will not calibrate on x100 only	Resistor R109 or potentiometer R12 (input switching board) malfunctioning
Pre-amplifier noisy on both ranges with no change in noise level between ranges	DEMODULATOR AND FILTER Choke, NLS 1757 or transistors Q23 or Q24 (pre-amplifier board) malfunctioning DC AMPLIFIER Feedback capacitors, C5 or C6 (pre-amplifier board) or integrating capacitor from input of DC amplifier to output, C25 (pre-amplifier board) malfunctioning

PRINTACT RELAY REPLACEMENT

The Printact relays (P/N 12BW3G), located on the five decade assemblies and on the amplifier assembly may be removed and replaced by performing the following steps. See figures 4-1 through 4-3.

1. Remove the board assembly from the instrument.

2. Grasp the relay housing between thumb and forefinger on the two sides not touching the metal retaining-clip.

3. Partially insert a thin bladed screwdriver between the metal clip and a side of the relay housing.

4. Gently twist the screwdriver to raise the clip away from the base of the housing. The bent tip of the clip will spring out of the hole in the relay printed circuit board.

5. Perform steps 3 and 4 for the other side of the relay.

6. Gently pull the relay away from its printed circuit board.

7. Ensure that the relay printed circuit board is free of contaminants. To remove contamination or organic origin, FREON is recommended. If means are taken to protect the plated printed circuit wires on the printed circuit board, rosin may be removed from the solder by sand blasting.

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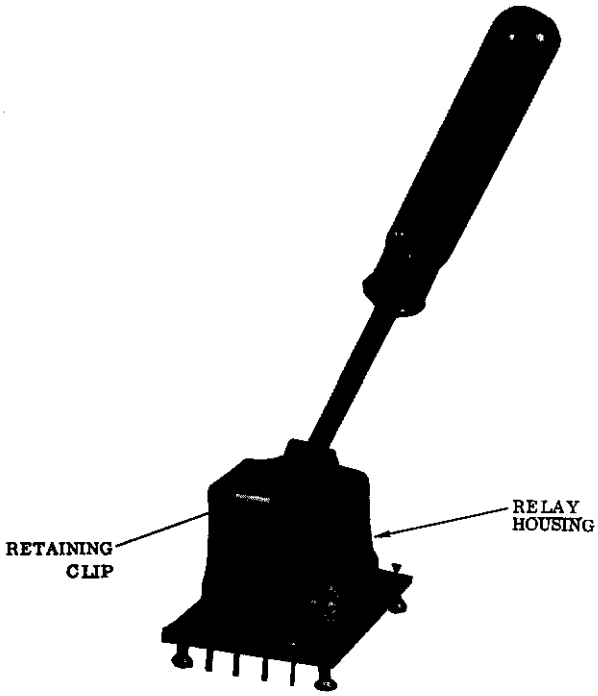

Figure 4-1. Relay Removal Initial Step

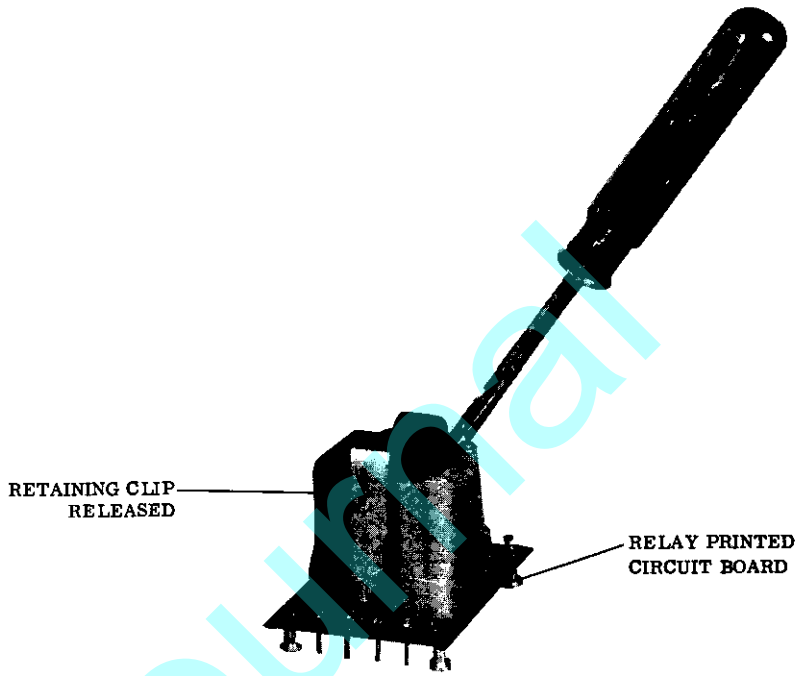

Figure 4-2. Relay Removal with One Side of Clip Released

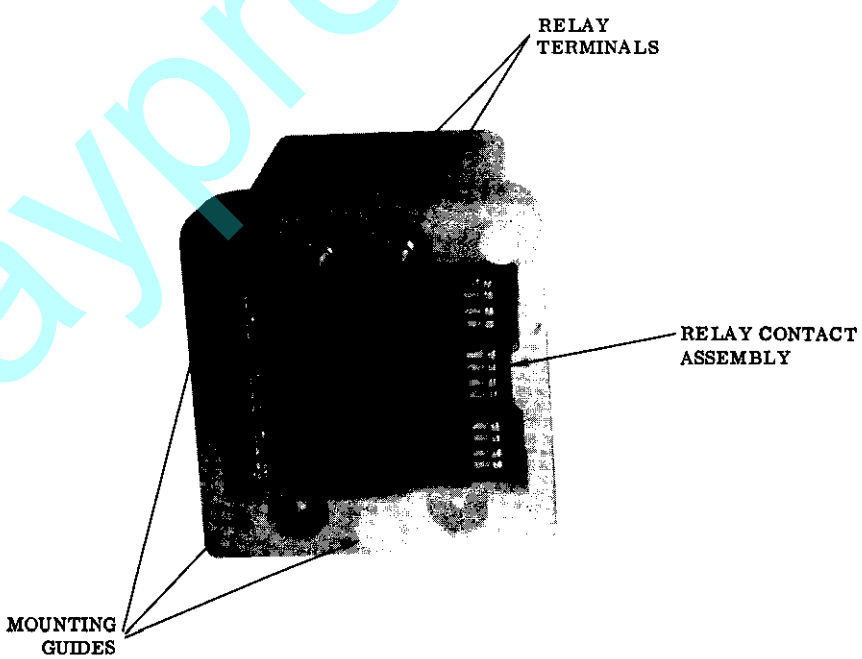

Figure 4-3. Relay Terminals and Mounting Guides

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NOTE

Mounting of relays prior to any soldering operation is not recommended since solder flux fumes could contaminate the contacts.

8. In handling relays, the following precautions should be observed:

   a. Do not attempt to adjust relay contacts. The relays are adjusted for correct contact pre-load by the manufacturer.

   b. Do not trade contact assemblies from relay to relay. The manufacturer's contact pre-load adjustment takes into account manufacturing tolerances of the entire relay assembly.

   c. Do not manipulate the contact assembly by hand. This may bend contacts and change the pre-load setting.

   d. Do not handle the moving armature blades. This avoids contamination or bending blades out of adjustment.

   e. Do not operate relay when not mounted on the printed circuit board. Back pressure on blades is required to start armature back into the magnetic field.

   f. Contacts on relay and board can be cleaned by buzzing relay with AC current at rated voltage when mounted on the circuit board. This also assures proper seating of any armature dislodged in shipment.

   g. Do not hand-adjust relay blades. The relays have been factory-adjusted for the required overtravel and wiping action. If the relay does not operate for any reason, replace it with another relay.

9. Remove the clear acetate cover protecting the armature and contact blades of the replacement relay.

10. Carefully insert the two terminals and mounting guides into the holes provided in the relay printed circuit board.

11. Press firmly against the top of the clip on the relay housing and insert the screwdriver blade between the clip and relay housing on one side of the relay.

12. Twist the screwdriver until the bent tip of the clip enters the adjoining hole in the relay printed circuit board and springs firmly against the base of the relay housing.

13. Perform steps 11 and 12 for the other side of the relay.

14. Attempt to insert a .003-inch shim under each corner of the relay, between a conductor and the relay seating surface. A no-go condition will indicate a properly seated relay.

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DIGITAL READOUT MAINTENANCE

The digital readout assembly (figure 4-4) does not ordinarily require maintenance other than lamp bulb replacement and an occasional cleaning. Most readouts have decals on the readout cover, on the top and bottom of each readout, to show which contact is providing the signal for each digit or symbol. If decals are not provided, see figure 4-5 for information to locate each digit or symbol contact point.

Lamp Bulb Replacement

When it is determined that a digit or symbol is not illuminating within a specific readout display, the lamp bulb may be replaced by performing the following steps:

1. Remove the four Allen-head screws attaching the bezel to the DOM chassis. The readout assembly may now be withdrawn from the instrument.

2. Locate the correct contact point for the defective bulb either by noting the decal on the specific readout or by referring to figure 4-5.

3. Remove the lamp board assembly (top or bottom) from the readout containing the defective bulb by removing the two attaching screws.

4. Gently withdraw the lamp board assembly away from the lamp block within the readout cover.

5. Unsolder defective bulb and replace it with a functioning T-1-3/4 14-volt bulb.

6. Re-assemble readout and readout assembly in reverse order of disassembly.

Readout Window Cleaning

CHICAGO MINIATURE LAMPS TYPE 1705
T-1 3/4 67¢ EA 4.00 BOX OF 10

Under extremely adverse dust or humidity conditions, the individual readout windows may require cleaning. If accumulated dust particles are likely to be unusually abrasive, a camel-hair brush or artist's sable brush should first be used to remove loose dust particles. The windows may then be cleaned with commercial isopropyl alcohol and lint-free paper, such as Kimwipes 900-L, manufactured by Kimberly-Clark, Neenah, Wisconsin. The windows may also be cleaned if they are dipped in alcohol and then blown dry with compressed air.

To remove the windows from the readout, perform the following steps:

1. Perform Step No. 1 under Lamp Bulb Replacement.

2. Remove readout retaining bar by removing two attaching screws.

3. Perform Step No.'s 3 and 4 (both top and bottom lamp boards) under Lamp Bulb Replacement for each readout to be cleaned.

4. Remove each two sets of lamp block attaching screws.

5. Gently press against one lamp block until the other lamp block may be removed and until windows can be withdrawn with finger-tip pressure.

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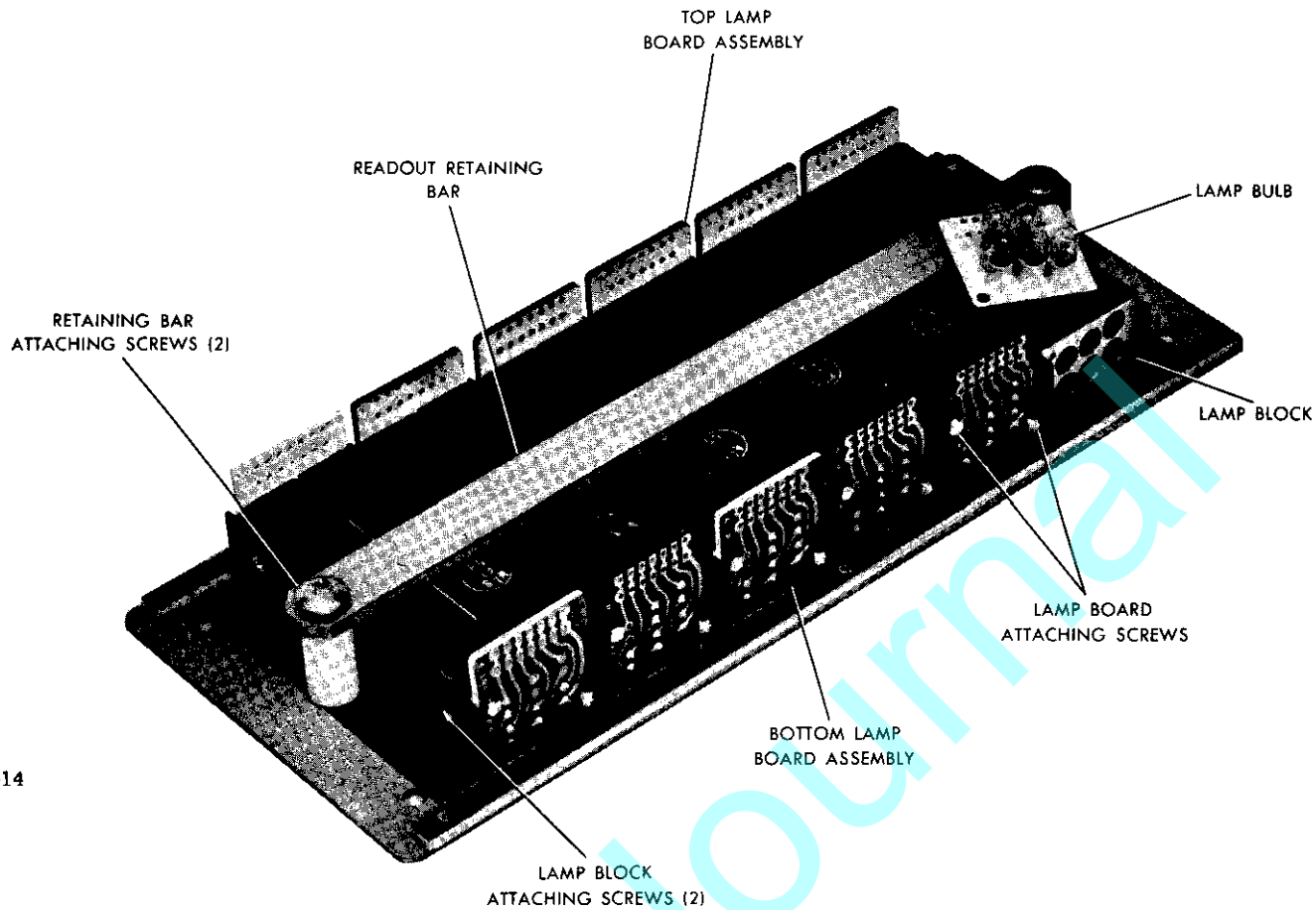

Figure 4-4. Readout Assembly

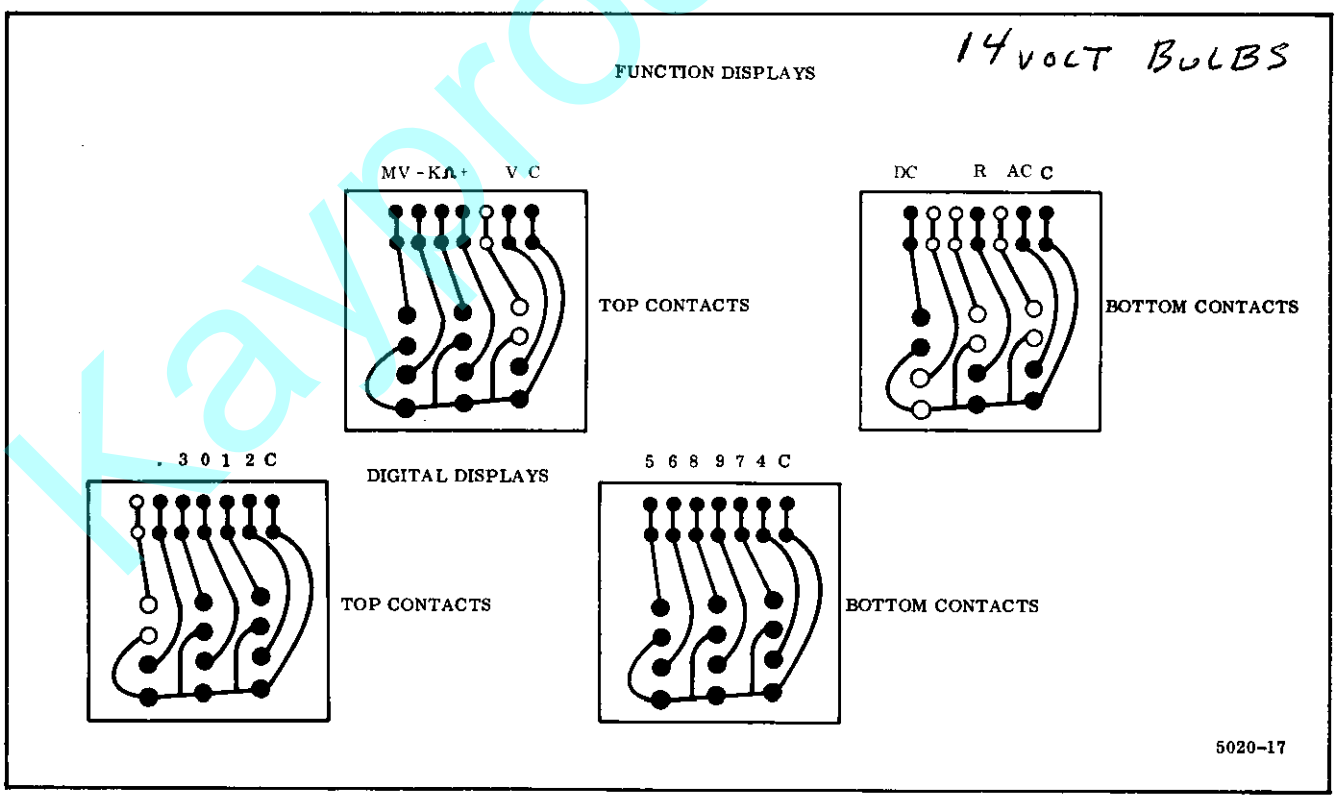

Figure 4-5. Lamp Bulb Contact Points

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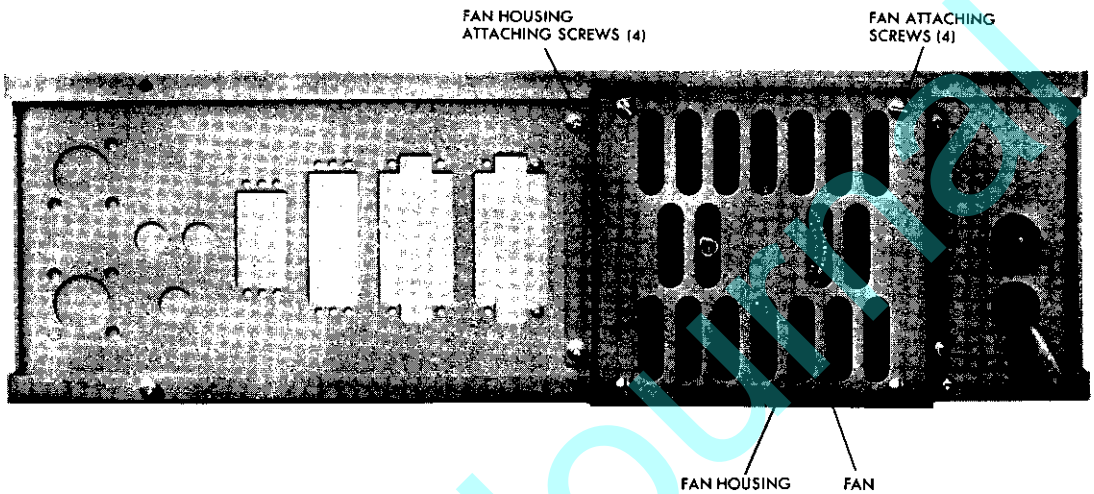

Figure 4-6. Rear View, Typical DVM with Fan

6. Clean the windows as set forth above.

NOTE

It is well to be systematic about this operation so as to avoid replacing the windows in improper order. Care should be taken to avoid replacing the windows backwards; this type of error is most likely to occur with windows marked 1, 0, 6, 8, or 9. Note that the engraved side always faces to the rear of the readout.

7. Stack the windows in proper order and press them together with mild finger-tip pressure. Avoid fingerprints on the windows. After ensuring that the numerals are right side up and that the engraved side faces the rear of the readout, gently slip the windows into the cover.

8. Re-assemble readout and readout assembly in reverse order of disassembly.

If the readout contains a Polaroid filter in front of the display, it may be removed and cleaned in the same manner as the readout windows. Care should be taken to re-install the filter so that the polarizing action is correct. Look through the filter at a piece of shiny metal, such as the chrome rim of a wrist-watch. If the metal shows a markedly violet cast, then the filter front is the surface closest to the eye.

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FAN LUBRICATION

Under normal operating conditions, the ventilating fan, located on the rear of the instrument, should be lubricated with two or three drops of SAE No. 10 oil approximately every three months.

To lubricate the fan, perform the following steps (see figure 4-6).

1. Remove the four screws attaching fan housing to chassis of instrument.

2. Tilt the top of fan housing assembly away from rear of instrument until fan motor is accessible.

3. Apply two or three drops of SAE No. 10 oil to lubrication opening in center of front of fan motor.

NOTE

The first time the fan is lubricated, it will be necessary to pierce the paper seal attached to the fan motor.

4. Replace fan housing assembly.

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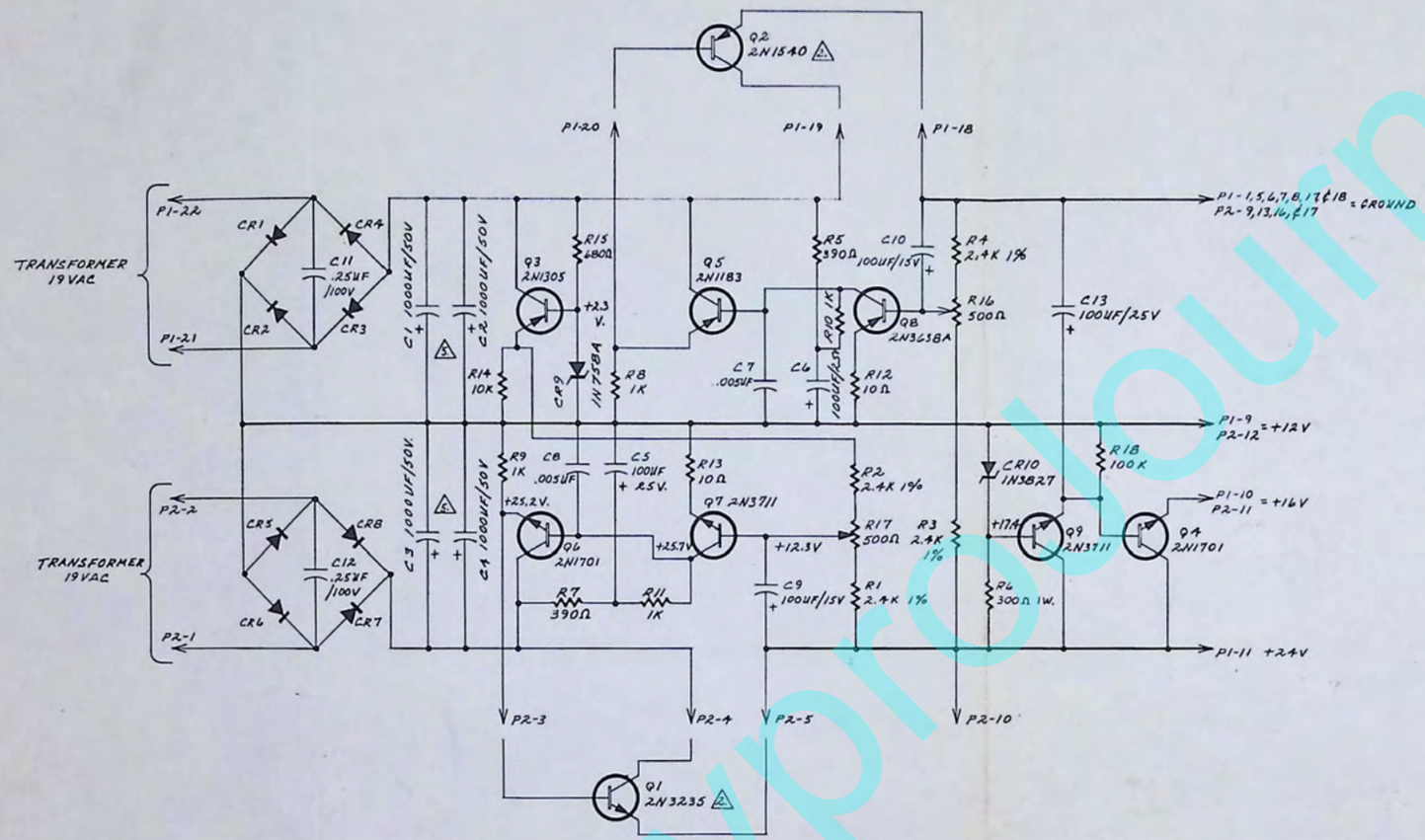
REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
C/5	F		Q8(2N3638A) WAS 2N3702 - ALSO REDRAWN JAC	3-29-66 JAC	3-30-66 R.T.W.



1. C1&C3 ALTERNATE 2000 UF CAP. MAY BE SUBSTITUTED FOR C1-4 1000UF CAP. (REF. SHT. 1)
2. RESISTORS 1/2W 5%
3. K1-4 ARE PW1220
4. Q1&2 ARE MOUNTED ON INNER CHASSIS; REF. DVM SUB-ASSEMBLY FOR CALL OUT
5. CR1-8 IN4003

NOTES, UNLESS OTHERWISE SPECIFIED

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
50-193	50-193	1	1
50-150	50-150	1	1
50-129	50-129	1	1
50-28	50-28	1	1
50-17	50-17	1	1
APPLICATION		QTY.	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.		
DRAWN	T. LAM	12-2-64
CHECK	L. KNAPIK	2-2-65
APPR	C. MEREDITH	2-2-65
RELEASE DATE		

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
POWER SUPPLY ASSEMBLY
SERIES 5000

SIZE	CODE IDENT NO.	
D	03626	50-7
SCALE	WEIGHT	SHEET 2 OF 3

F 50-7 SHT 2

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11/65 DIETERICH-POST CLEARPRINT 10004-10

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
0/A	D	ALL	REDRAWN — ADDED R59 THRU R66 & CR37 THRU CR44	7-16-65 AEW	R.T.W.
C/7	E	ALL	R3 CHG. FROM 11.11K TO 11.111K	8-27-65 JAC	L. Knapik
B/8	F	ALL	CORRECTED SCHEMATIC ERROR	9-8-65 JAC	R.T.W.
C/2	G	ALL	P2-18(GND) ADDED	10-8-65 JAC	L. Knapik
B/3	H	ALL	R38 DUPLICATED; ONE REVISED AS R39; ADDED RELAY NUMBERS	12-14-65 JAC	L. Knapik
B/7			INCORP E.O. 1 CHG "B"		

P2-15 (+24V)
P2-10 RANGE LOGIC SET
P2-16 (+16V)
P2-1 & 2 (LO OUT)
P2-3 & 4 (HI OUT)
P2-7 & 8 (REF HI IN)
P2-5 & 6 (REF LO IN)
P2-13 (DN PULSE IN)
P2-11 (UP PULSE OUT)
P2-18 (GND)
P2-17 (+12V)

RELAY "2" "4" "2" "1"

R1 10K .01% R2 20K .01% R3 40K .01% R4 20K .01% R5 11.111K .01%
R6 10K .01% R7 20K .01% R8 40K .01% R9 20K .01%

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24

CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8 CR9 CR10 CR11 CR12 CR13 CR14 CR15 CR16 CR17 CR18 CR19 CR20 CR21 CR22 CR23 CR24 CR25 CR26 CR27 CR28 CR29 CR30 CR31 CR32 CR33 CR34 CR35 CR36 CR37 CR38 CR39 CR40 CR41 CR42 CR43 CR44

K1 K2 K3 K4

P1-1 (0) P1-2 (1) P1-3 (2) P1-4 (3) P1-5 (4) P1-6 (5) P1-7 (6) P1-8 (7) P1-9 (8) P1-10 (9)
P1-15 P1-16 P1-17 P1-18 P1-19 P1-20 P1-21 P1-22
P2-12 (UP PULSE IN) P2-14 (DN PULSE OUT)

AMPLITUDE OF UP & DN PULSES AT P2-12 & P2-13 APPROX. 12 VOLTS

8. P2 MATES WITH J16 J20 J24 & J28
7. P1 MATES WITH J15, J19, J23 & J27
6. RESISTORS ARE 1/2W CARBON 5% TOL
5. DIODES ARE 5003-002
4. R1 THRU R8 ARE PW2016
3. Q21 THRU Q24 ARE 2N1304
2. Q1 THRU Q20 ARE 2N1305 (Q9-Q20 2N914A MAY SUBSTITUTE)
1. C1 THRU C8 ARE 0.01 MFD/150V

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-17	50-17	4	4
50-26	50-28	3	3
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

CONTR. NO.		
DRAWN	L. KNAPIK	4-6-65
CHECK	R. T. WARNER	4-20-65
APPR	C. MEREDITH	4-20-65

RELEASE DATE 4-21-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
DECADE ASSEMBLY
SERIES 5000

SIZE	CODE IDENT NO.	
D	03626	50-61
SCALE	WEIGHT	SHEET 2 OF 2

50-61 SH 2 H

Kaypro Journal

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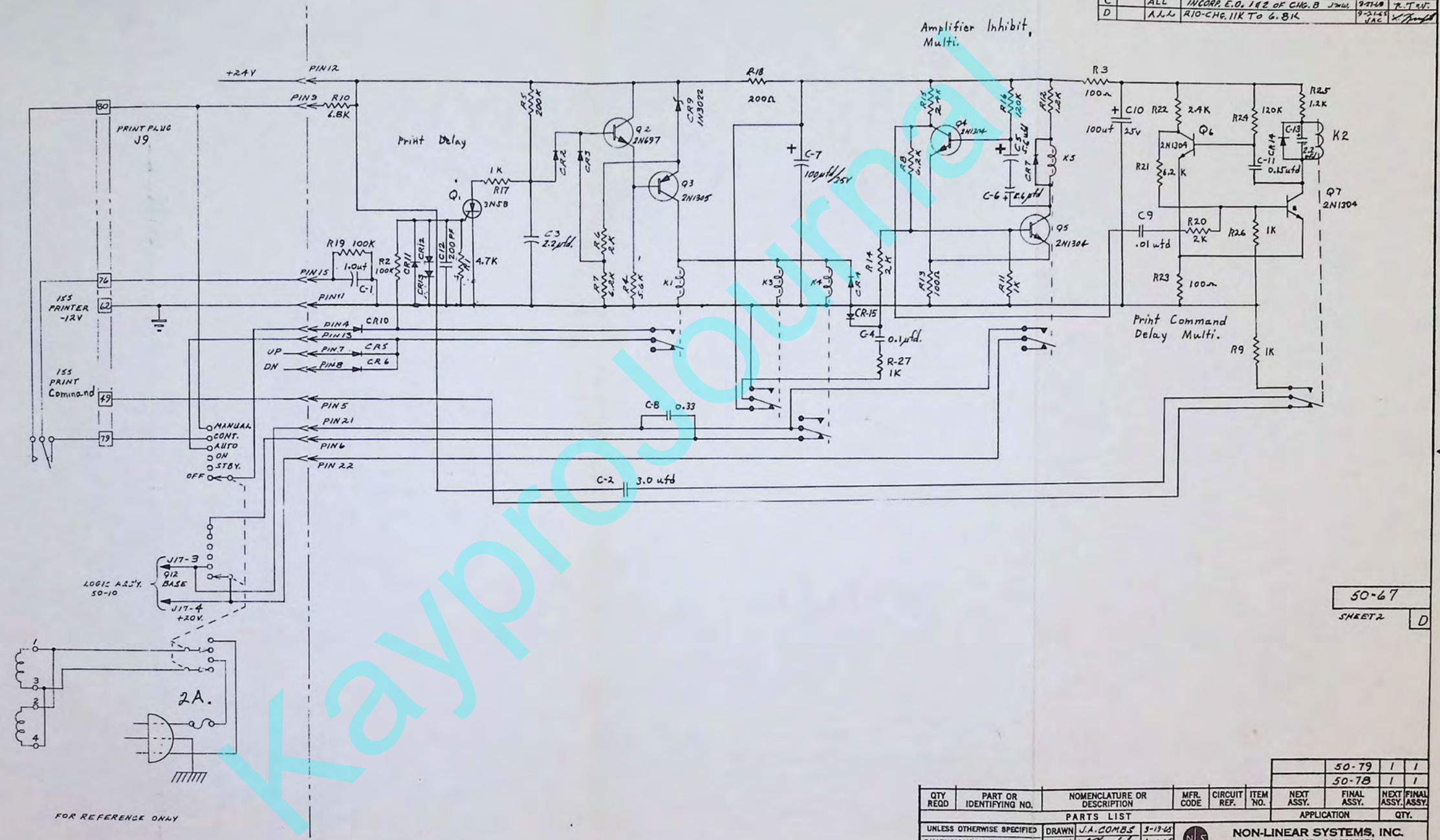
REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A			Added Print Comm. Delay Multi. Revised Print Delay Circuit	5-5-65	R.T.W.
B		1039 ON	INCORP E.O. 1 OF CHG A	5-7-65	R.T.W.
C		ALL	INCORP. E.O. 162 OF CHG. B	9-7-65	R.T.W.
D		ALL	R10-CHG. 11K TO 6.8K	9-21-65 JAC	



4. CR8 Omitted
3. ALL DIODES ARE NLS 5003-002
2. ALL RESISTORS ARE 1/2 W 5%
1. ALL RELAYS ARE NLS 5-12-34
NOTES, UNLESS OTHERWISE SPECIFIED.

DIETZGEN-POST CLEARPRINT 3000H-10

50-67
SHEET 2 D

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
		PARTS LIST				APPLICATION		QTY.	
							50-79	1	1
							50-78	1	1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ± .010 ANGLES ± 0° 30' FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 4-15-65 (2)

DRAWN J.A. COMBS 3-13-65
CHECK [signature] 4-15-65
APPR R.T. Warner 4-15-65
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC DVL-1
"PRINT CONTROL" BOARD
5000 SERIES

CODE IDENT NO. 03626 | SIZE D | 50-67
SCALE | WEIGHT | SHEET 2 OF 2

Kayproducts Journal

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
D/A C/7 B/B	A	ALL	REDRAWN – ADDED R59 THRU R66 & CR37 THRU CR44 R3 CHG. FROM 11.11K TO 11.111K CORRECTED SCHEMATIC ERROR	9-865	R.T.W.
	B	ALL	R39 WAS R38 INCORR. E.O.1 OF CHG "A"	2-11-66 JAC	2-11-66 R.T.W.

P2-15 (+24 V)
P2-10 RANGE LOGIC SET
P2-16 (+16 V)
P2-1 & 2 (LO OUT)
P2-3 & 4 (HI OUT)
P2-7 & 8 (REF HI IN)
P2-5 & 6 (LO IN)
P2-13 (DN PLSE IN)
P2-12 (UP PLSE IN)

RELAY "2*" "4" "2" "1"

R4 20K .005% R3 40K .005% R2 20K .005% R1 10K .005% R5 11.11K .005%
R9 20K .005% R8 40K .005% R7 20K .005% R6 10K .005%

CR32 R14 15K R15 15K CR3 CR4 R16 15K R17 15K CR7 CR33 CR8 R18 15K R19 15K CR11 CR34 R20 15K R21 15K CR14 CR35

Q1 Q2 Q4 Q3 Q6 Q5 Q7 Q8

CR37 CR38 CR39 CR40 CR41 CR42 CR43 CR44

R22 3.9K R23 3.9K R24 3.9K R25 3.9K R26 3.9K R27 3.9K R28 3.9K R29 3.9K

C1 C2 C3 C4 C5 C6 C7 C8

R30 47K R31 47K R32 47K R33 47K R34 47K R35 47K R36 47K R37 47K

R59 10K R40 2.7K R41 2.7K R60 10K R61 10K R42 2.7K R43 2.7K R62 10K R63 10K R44 2.7K R45 2.7K R64 10K R65 10K R46 2.7K R47 2.7K R66 10K

CR1 CR2 CR5 CR6 CR9 CR10 CR12 CR13

R48 1K R49 1K R50 1K R51 1K

CR17 CR18 CR19 CR20 CR21 CR22 CR23 CR24 CR25 CR26 CR27 CR16 CR15 CR36 IN756

C9 .002 uf 150V

K1 K2 CR31 K3 CR30 K4 CR29 CR28

Q24 Q23 Q22 Q21

R10 2.2K R11 2.2K R12 2.2K R13 2.2K

Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q10 Q9

R54 5.6K R55 5.6K R56 5.6K R57 5.6K R58 5.6K R53 5.6K R39 10K R52 5.6K R38 10K

P1-1 (0)
P1-2 (1)
P1-3 (2)
P1-4 (3)
P1-5 (4)
P1-6 (5)
P1-7 (6)
P1-8 (7)
P1-9 (8)
P1-10 (9)

P2-11 (UP PLSE OUT)
P2-14 (DN PLSE OUT)
P1-15
P1-19
P1-16
P1-20
P1-17
P1-21
P1-18
P1-22
P2-17 (+12V)

8. R1 THRU R4, R6 THRU R9: ACCURACY ±.005%, MATCHED TO .0025% TEMP. COEFFICIENT 0-50 PPM, ALL IN THE SAME DIRECTION.
P2 MATES WITH J28
7. P1 MATES WITH J27
6. RESISTORS ARE ½W CARBON 5% TOL
5. DIODES ARE 5003-012
4. R1 THRU R9 ARE PW2016
3. Q21 THRU Q24 ARE 2N1304
2. Q1 THRU Q20 ARE 2N1305 (Q9-Q20 2N404A MAY SUBSTITUTE)
1. C1 THRU C8 ARE 0.01 MFD/150V

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-150	50-150	1	1
50-28	50-28	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.		
DRAWN	L. KNAPIK	5-21-65
CHECK	R. T. WARNER	5-21-65
APPR	R.T. WARNER	5-21-65
RELEASE DATE	4-8-65	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

4TH/5TH SCHEMATIC
DECADE ASSEMBLY
MODEL 5010 & 5015

SIZE	CODE IDENT NO.	
D	03626	50-114
SCALE	WEIGHT	SHEET 2 OF 2

8: 50-114 SH 2

Kaypro Journal

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
O/A	B	ALL	REDRAWN LAG (PP) 2-21-66	4-1-66	R.T.W.

MOD-DEMOD

DELAY #1

DELAY #2

RANGE SWITCH

BRISTOL CHOPPER C1417-15

NOTES:
1. ALL RESISTORS ½W ±1% UNLESS OTHERWISE SPECIFIED IN AMPLIFIER, ½W ±5% IN MOD-DEMOD
2. ALL DIODES NLS 5003-002 UNLESS OTHERWISE SPECIFIED

⚠ CHOKE L, IS 2000H; ELECTRICAL EQUIVALENT IS ULS 3-13
⚠ D1 IS SET FOR 150 μSEC
⚠ D2 IS SET FOR 400 μ SEC

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
50-193	50-193		1	1	
50-129	50-129		1	1	
NEXT ASSY.	FINAL ASSY.	APPLICATION	NEXT ASSY.	FINAL ASSY.	QTY.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.		
DRAWN	M. BAGULA	7-26-65
CHECK		
APPR	R.T. WARNER	7-26-65
RELEASE DATE	8-25-65 E	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

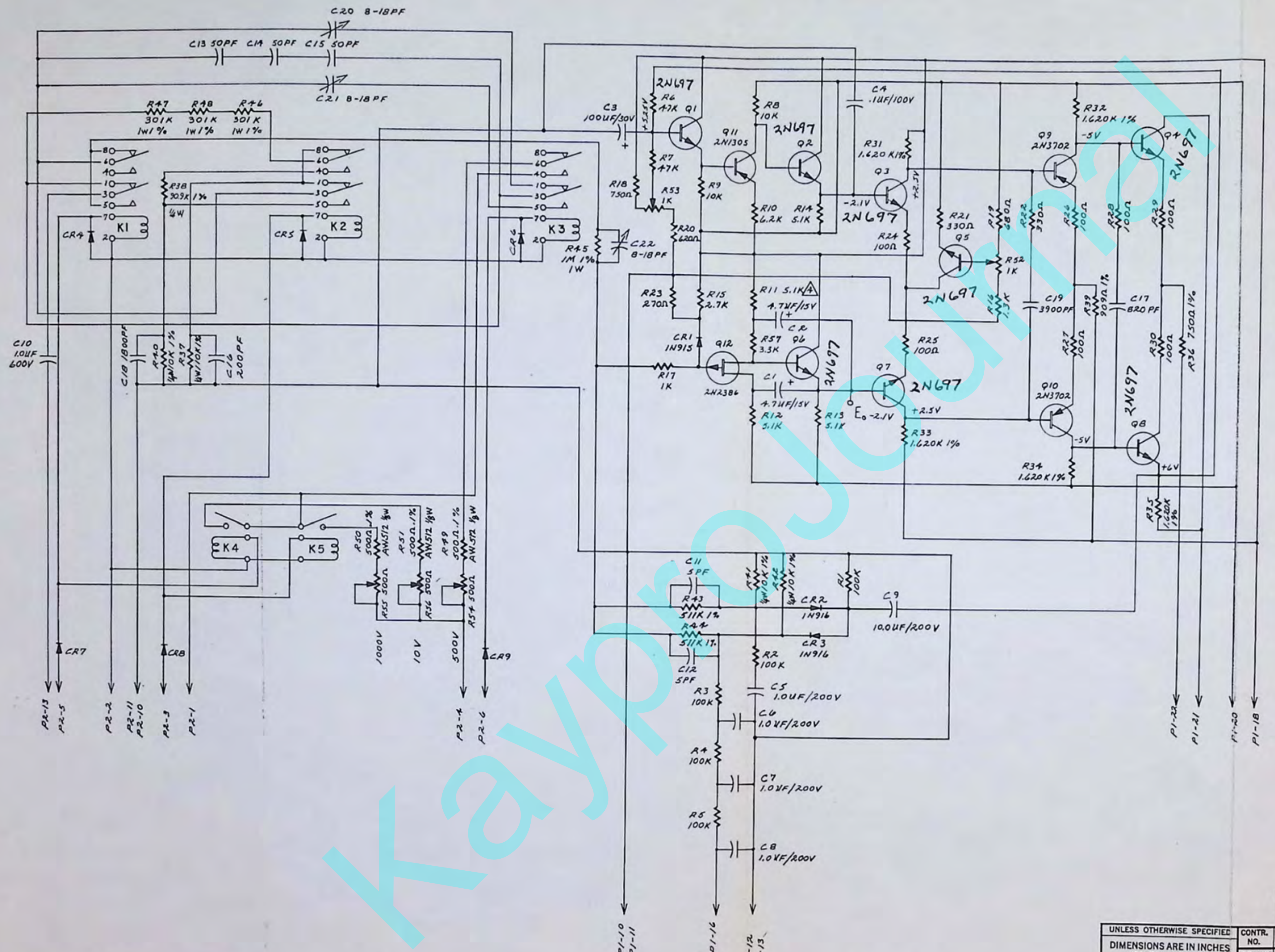
PREAMPLIFIER, BOARD (MOD & DEMOD)
MODEL 5014 & 5020

SIZE	CODE IDENT NO.	
D	03626	50-127
SCALE	WEIGHT	SHEET 2 OF 2

50-127 SH2 B

Kaypro Journal

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
B/6&7	A	ALL	ADDED CR7, 8, & 9	12-22-65	R.T.W.
C/5	B	ALL	C20-22 (8-18PF) WAS 8-10 PF)	3-23-66	3-26-66 R.T.W.



2N2498

⚠ IF E₀ IS LESS THAN -1.0V CHG. R11 TO 12K 5%
IF E₀ IS STILL LESS THAN -.6V CHANGE Q12 (2N2386)
IF E₀ IS NOW MORE NEG. THAN -3.5V CHG R11 BACK TO 5.1K 5%.
OPTIMUM E₀ IS -2.1V

3. ALL RESISTORS ARE ½ WATT 5% TOL.
2. ALL DIODES ARE NLS 5003-002
1. ALL TRANSISTORS ARE 2N697 (HEAT SINKS ON Q4 & Q8)

NOTES, UNLESS OTHERWISE SPECIFIED.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010 ANGLES ±0° 30'
FRACTIONS ±1/32
MATERIAL

50-193	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

CONTR. NO.
DRAWN J.A. COMBE 9-27-65
CHECK 10-9-65
APPR 10-9-65
RELEASE DATE 10-12-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

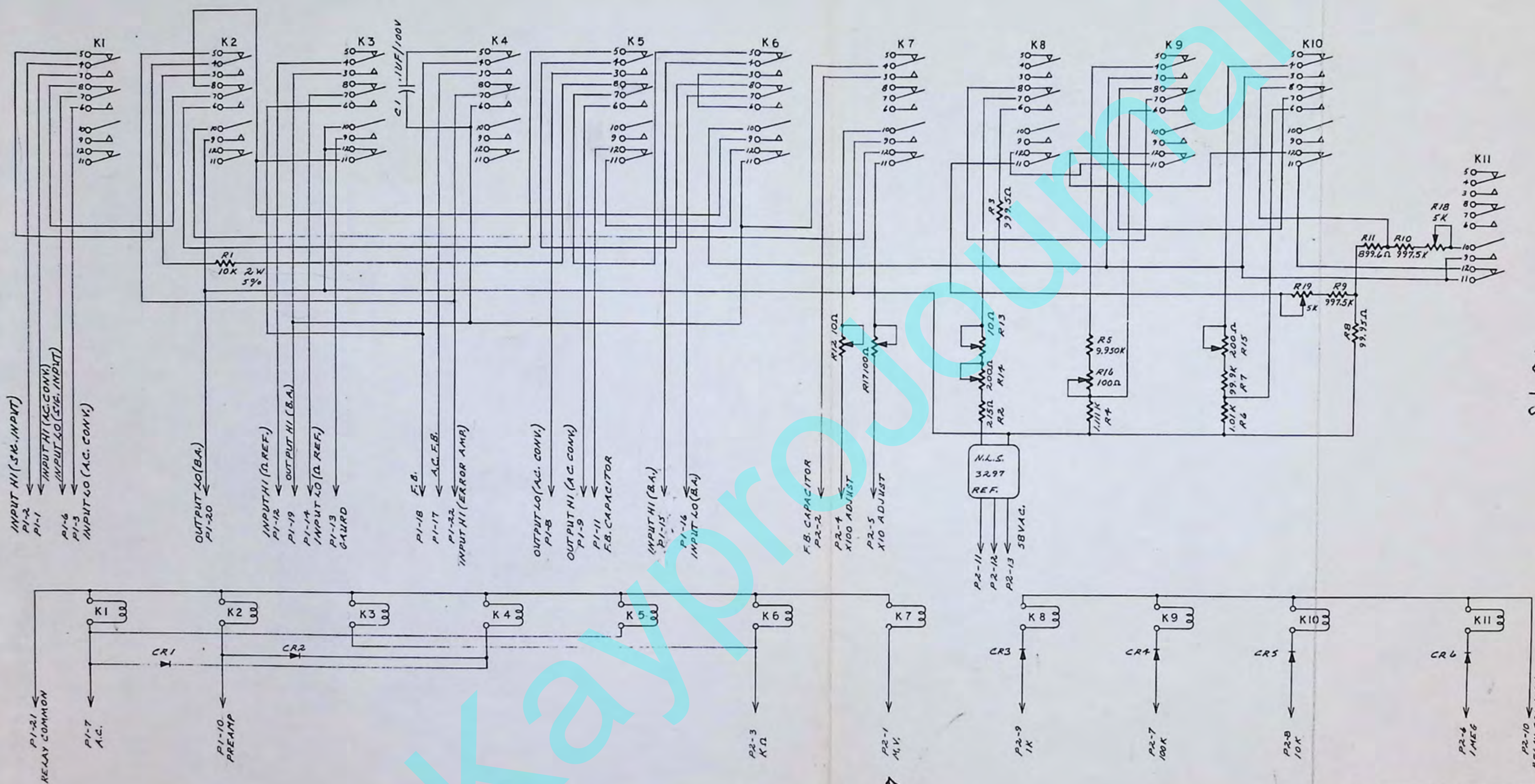
SCHEMATIC
A.C. ATTENUATOR & CONVERTER BD.
MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-148
SCALE | WEIGHT | SHEET 2 OF 2

B 50-148 SH 2

kayprojournal

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	REVISED & REDRAWN	9-22-65 JAC	10-5-65 R.J.W.
	B	ALL	R8 CHGD FROM 99.95K TO 98.95Ω	11-17-65 JAC	R. Warner
	C	ALL	R1 CHGD FROM ½W TO 2W ADDED C1	12-23-65 JAC	R. Warner



AUTO RANGE DELAY & DRIVER BOARD → P1-14

J39 - P2
J40 - P1

3. ALL RELAYS ARE PRINTACT
2. ALL RESISTORS ARE N.L.S. PW1220
1. ALL DIODES ARE N.L.S. 5003-002.
NOTES, UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010 ANGLES ±0° 30'
FRACTIONS ±1/32

MATERIAL

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
50-193	50-193	1	1
APPLICATION		QTY.	

CONTR. NO.		
DRAWN	R. GROVE	7-27-65
CHECK	M. BAGULA	7-27-65
APPR	R. WARNER	7-27-65
RELEASE DATE		

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
INPUT SWITCHING
MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-172
SCALE | WEIGHT | SHEET 2 OF 2

50-172 sh 2 C

DIETZGEN-POST CLEARPRINT 1000H-10

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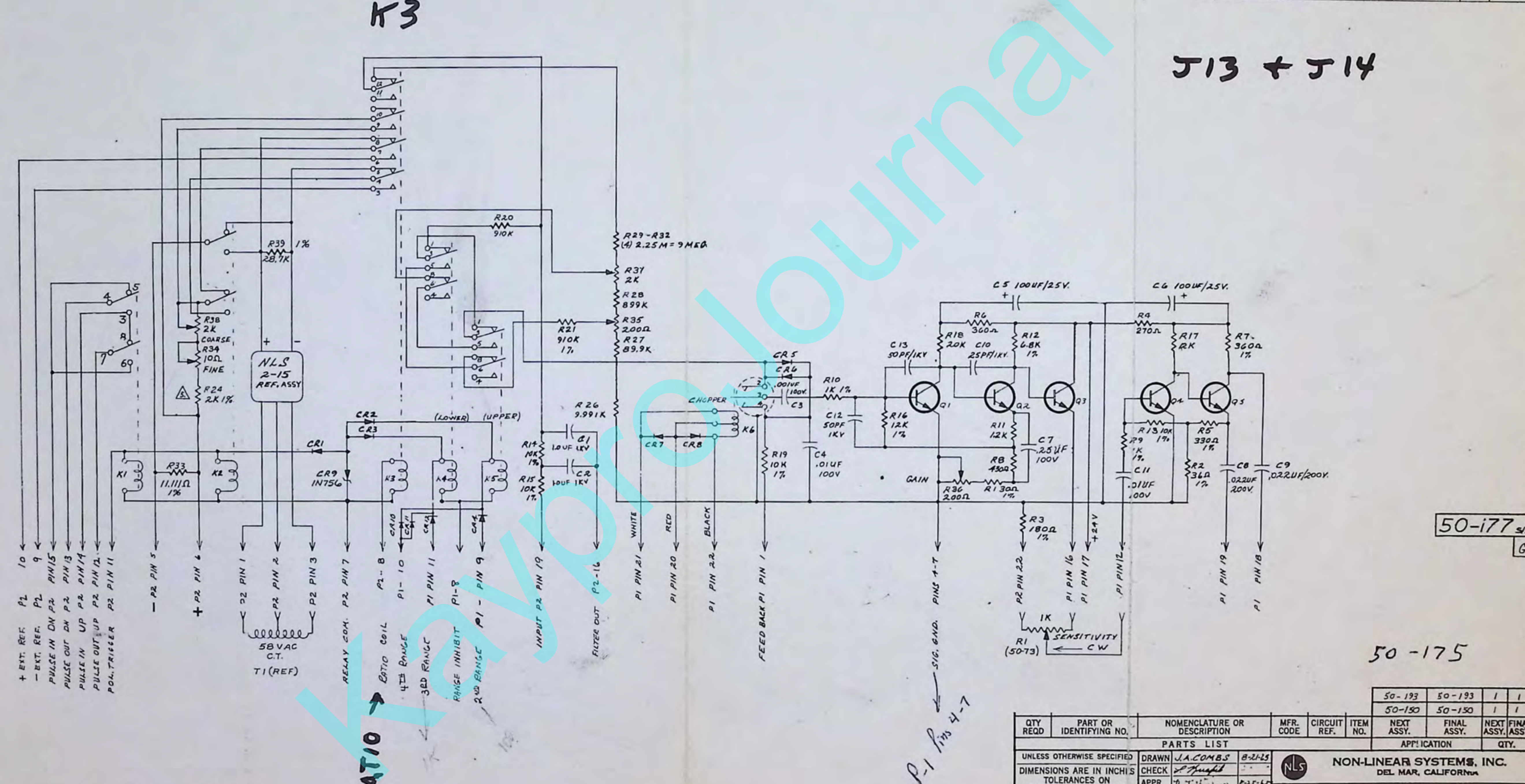
REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A		ALL	P1-14 WAS 15 PIN 15 WAS 14	8-26-65	[illegible]
B		ALL	2-15 REFERENCE ASSY WAS 2-11	9-3-65	[illegible]
C		ALL	NOTE 2 WAS CR-1-CR-8 RAM	9-25-65	R.T.W.
D		ALL	INCORP. E.O.1 OF CHG 'C'	10-19-65	[illegible]
E		ALL	REVERSED P2-14 & -15; P2-14 CHGD FROM K1-8 TO K1-3	11-23-65	R. Warner
F		ALL	CR9 1N756 WAS 1N963B EO 1 OF CHG D	12-20-5	R. Warner
G		5015.771 ALL 5020	E.O. 1 & 2 OF CHG F INCORP. ADDED R33; R38(2K) WAS 20K; R34(10Ω) WAS 100Ω, & R24(2K) WAS 20K	3-23-66 JAC	3-24-66 R.T.W.



△5 SELECT TO MATCH 2-15 REFERENCE

NOTES-
1. RESISTORS R1-R22 ARE ½W 1% GENERAL PURPOSE; R23-R25 PW 1220; R26-R32 PW 2016.
2. DIODES CR1-CR8 & 10-12 ARE 5003-002 (UG315)
3. ALL TRANSISTORS ARE TI 418 Q1-Q5.
4. RELAYS (K1-3) ARE PRINTACT 12BW3G; RELAYS (K4 & 5) ARE BABCOCK BR74-450A8

						50-193	50-193	1	1
						50-150	50-150	1	1
QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
PARTS LIST						APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 ANGLES ± 0° 30'
FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 8-25-65

DRAWN J.A. COMBS 8-21-65
CHECK [illegible]
APPR [illegible] 8-25-65
MATERIAL
FINISH

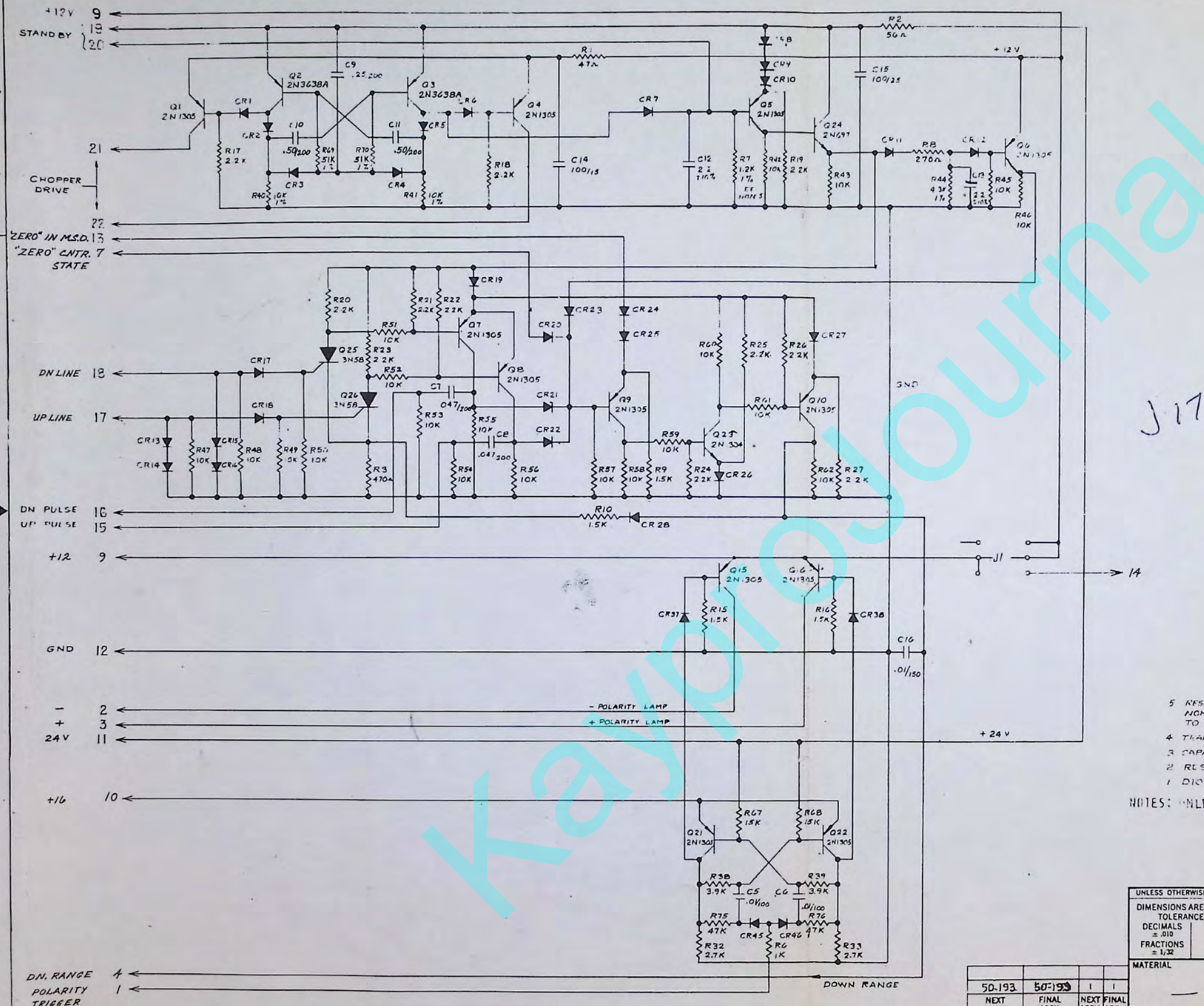
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC

AMPLIFIER, RANGE, & POLARITY
MODEL 5015 & 5020

CODE IDENT NO. 03626 | SIZE D | 50-177
SCALE | WEIGHT | SHEET 2

DIETZGEN CLEARPRINT



NOTES: UNLESS OTHERWISE SPECIFIED—

1. DIODES ARE [illegible]
2. RESISTORS ARE ½W 5%
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 Q11 THRU Q16
5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 12K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC #637.

REVISIONS

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	REMOVED FOLLOWING: RANGE CNTR. FLIP-FLOPS; DECIMAL RELAY BUF. DECODING DIODES. SEE SHT 1 CHG "A" FOR REVISED PARTS LIST REVISED & REDRAWN	12-8-65 JAC	R.T. [illegible]
D7	B	759 ON	INCORP. EO 1 OF CHG A	4-1-66	R.T. [illegible]

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-193	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 — ANGLES ± 0° 30′
FRACTIONS ± 1/32

MATERIAL —

CONTR. NO.
DRAWN A.R. WALLIN 7-29-65
CHECK
APPR R.T. [illegible] 7-20-65
RELEASE DATE 8-2-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

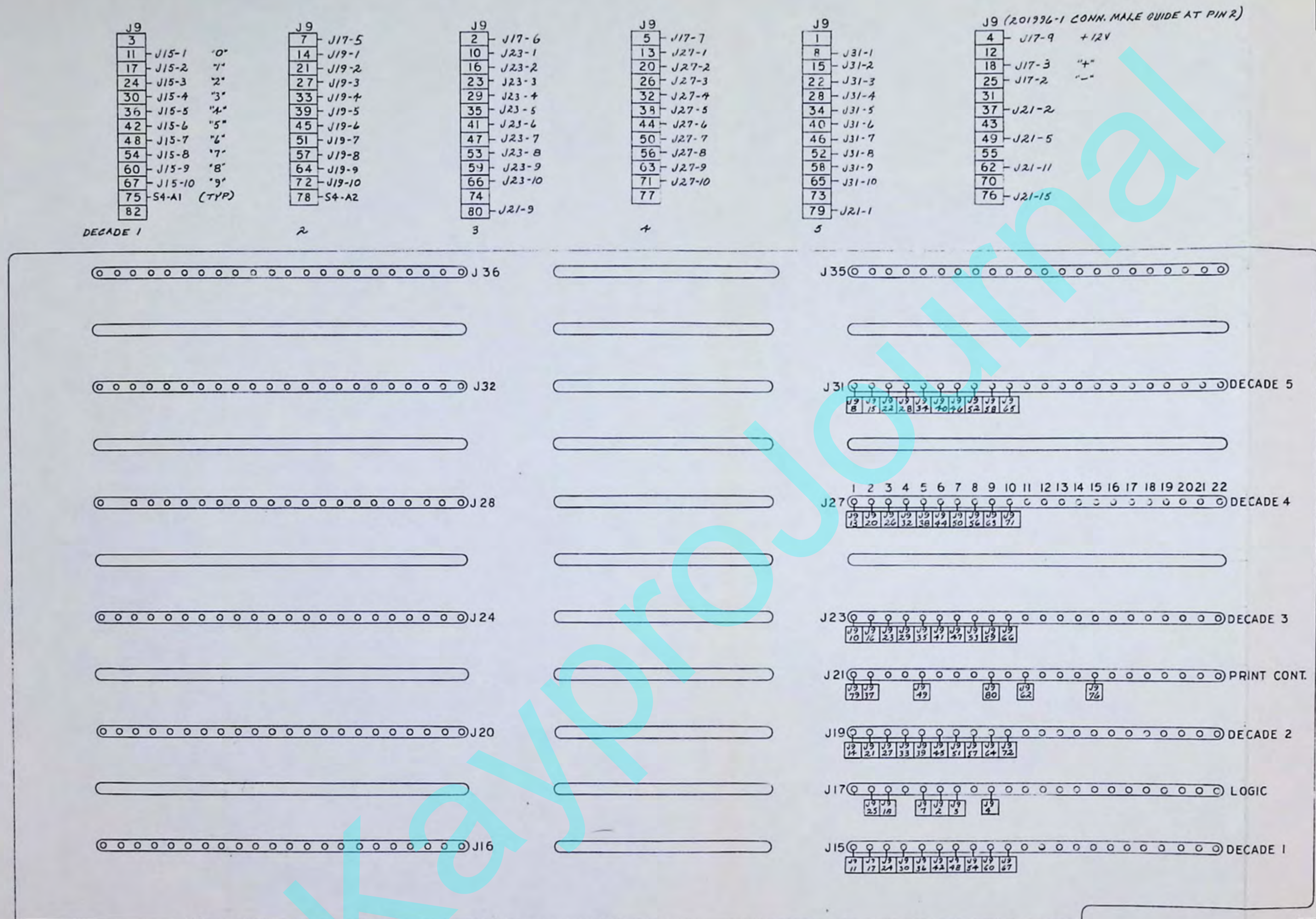
SCHEMATIC — LOGIC ASSEMBLY

MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-191

SCALE — | WEIGHT — | SHEET 2 of 3

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	ALL	ADDED S4-A1 & S4-A2 CONN. J9-4 WAS CONN. TO. J17-14 J9-5 WAS CONN. TO. J17-16 J92 WAS CONN. TO. J17-17 J9-7 WAS CONN. TO. J17-18 J9-18 WAS CONN. TO. J17-20 J9-25 WAS CONN. TO. J17-21	9-27-65 R.O.W.	



QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010 ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

CONTR. NO.
DRAWN J.A. COMBS 8/2/65
CHECK 8-25-65
APPR
RELEASE DATE 8-11-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC DVL-I

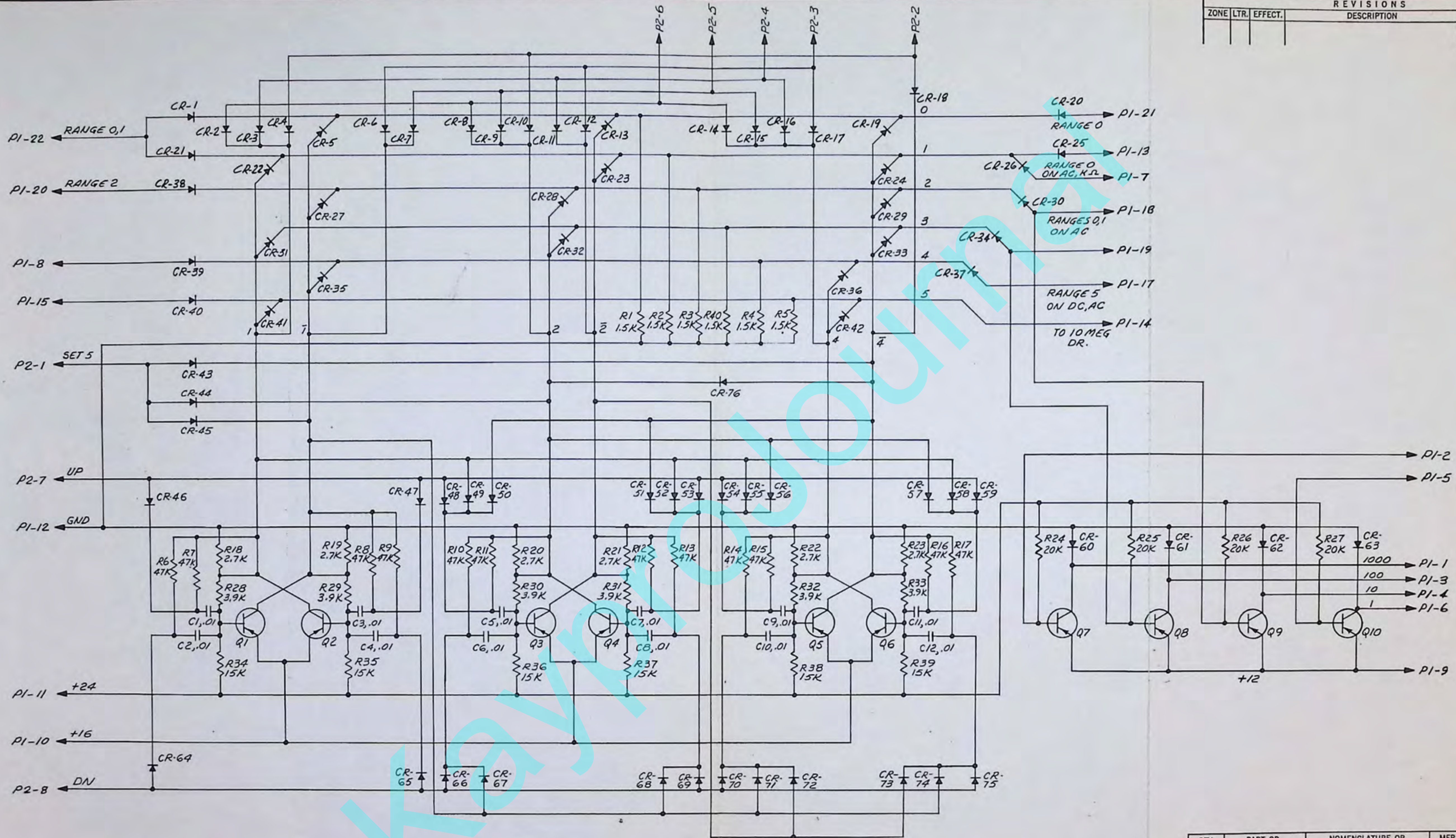
ADDITION FOR 5 DIGIT PRINT-OUT

MODEL 5015 & 5020

SIZE D CODE IDENT NO. 03626 50-202

SCALE WEIGHT SHEET 2 OF 3

ZONE	LTR.	EFFECT.	REVISIONS DESCRIPTION	DATE	APPROVED



3. ALL RESISTORS ARE 1/2W 5%.
2. ALL DIODES ARE TYPE UG 315 (5003-002).
1. ALL TRANSISTORS ARE 2N1305.
NOTES: UNLESS OTHERWISE SPECIFIED.

50-193	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010 ANGLES ±0° 30'
FRACTIONS ±1/32
MATERIAL

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

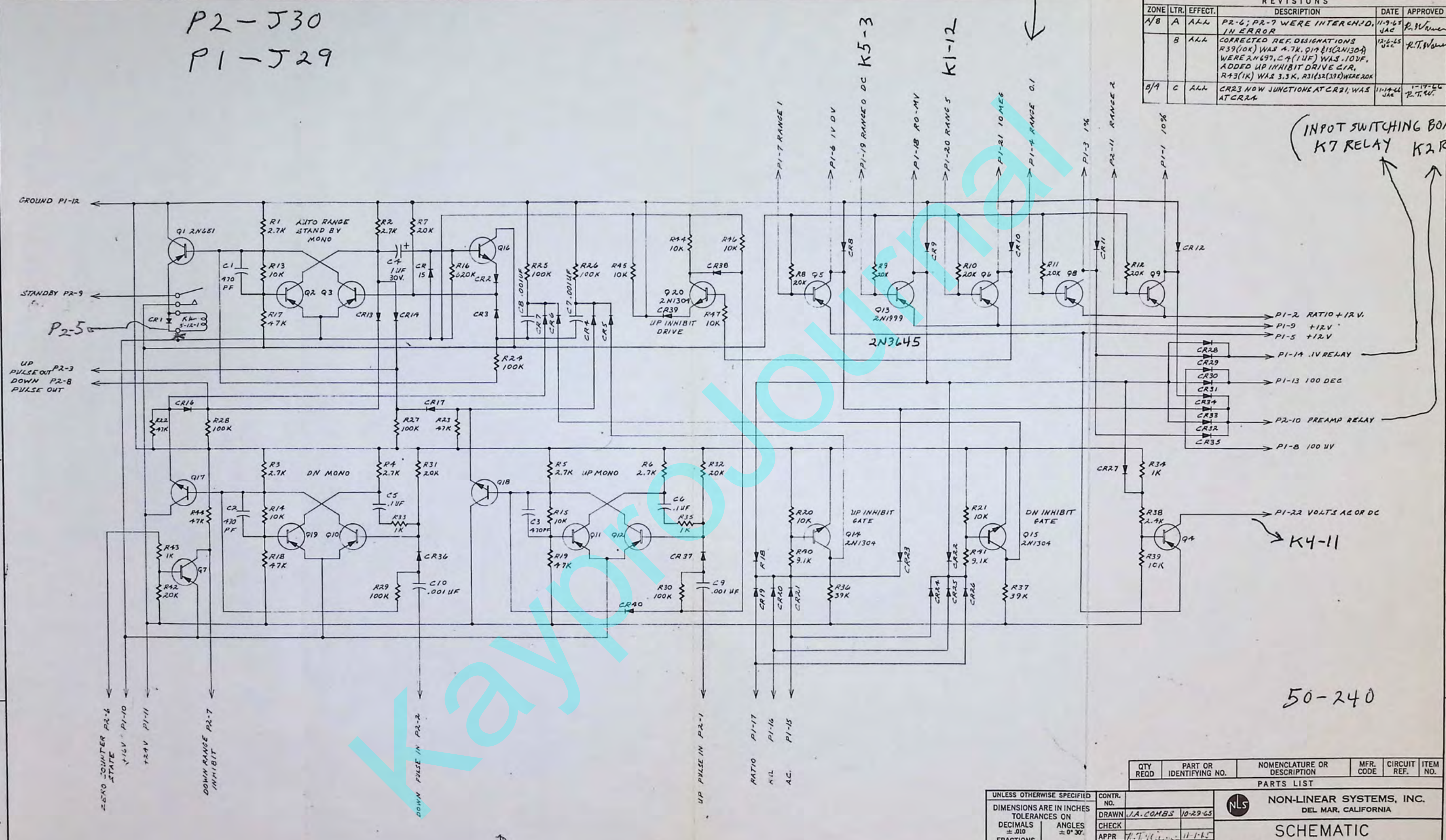
CONTR. NO.
DRAWN Hanrahan 10-30-65
CHECK 11-3-65
APPR 11-3-65
RELEASE DATE 11-4-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

AUTO-RANGE COUNTER
MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-237 | REV.
SCALE | WEIGHT | SHEET 2 OF 3

J25
50-237 SH2



ZONE	LTR.	EFFECT.	REVISIONS DESCRIPTION	DATE	APPROVED
A/8	A	ALL	P2-6; P2-7 WERE INTERCH'D. IN ERROR	11-9-65 JAC	R.T.W.
	B	ALL	CORRECTED REF. DESIGNATIONS R39(10K) WAS 4.7K, Q14 & 15 (2N1304) WERE 2N697, C4(1UF) WAS .10UF. ADDED UP INHIBIT DRIVE CIR. R43(1K) WAS 3.3K, R31 & 32 (39K) WERE 20K	12-6-65 JAC	R.T.W.
B/4	C	ALL	CR23 NOW JUNCTIONS AT CR21; WAS AT CR24	11-14-66 JAC	1-17-66 R.T.W.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-193	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
ANGLES ±0° 30'
FRACTIONS ±1/32

MATERIAL

CONTR. NO.
DRAWN J.A. COMBS 10-29-65
CHECK
APPR R.T.W. 11-1-65
RELEASE DATE 11-4-65

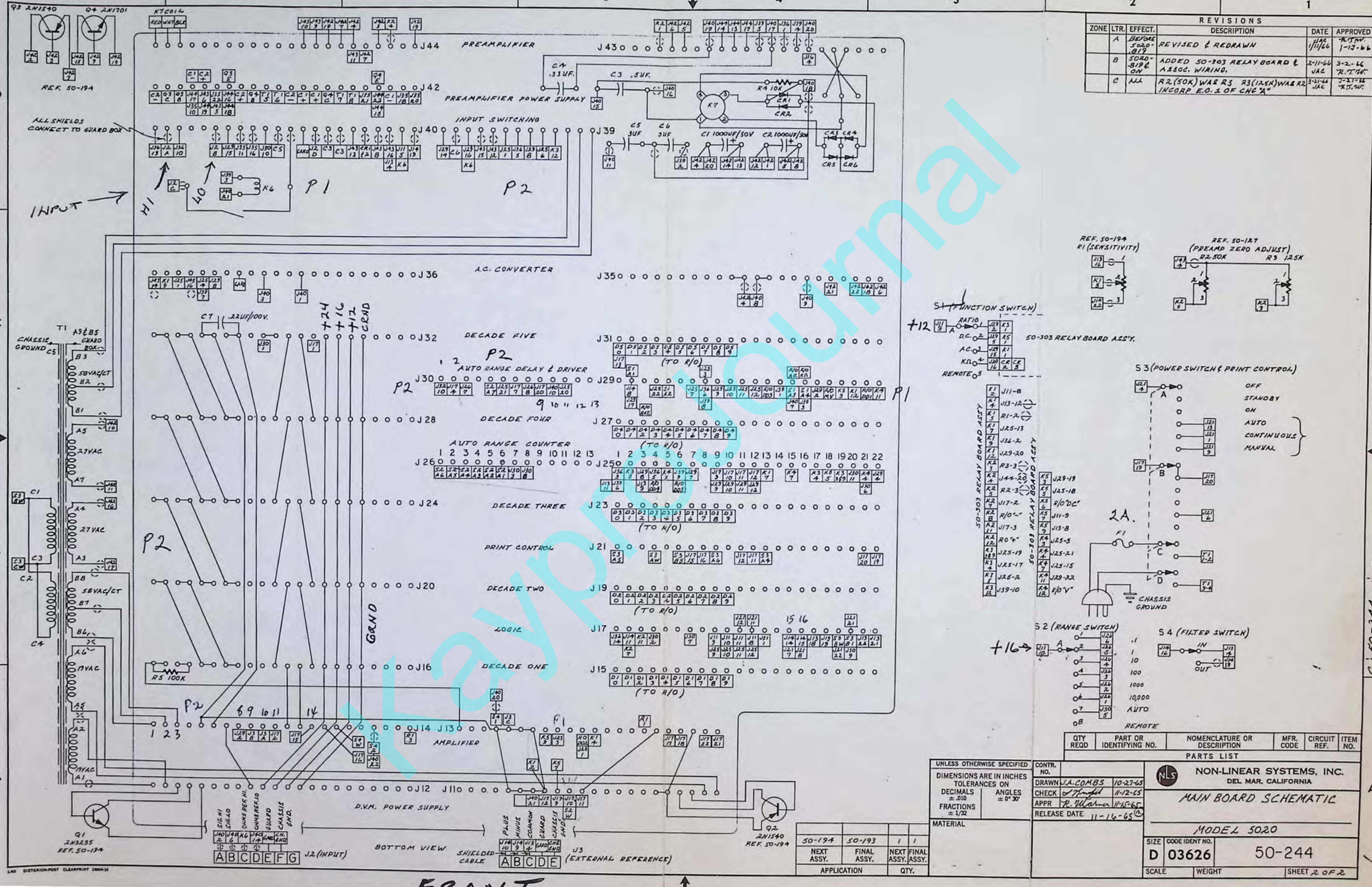
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC

AUTO RANGE DELAY & DRIVER BOARD
MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-242
SCALE | WEIGHT | SHEET 2 OF 3

3. ALL PNP TRANSISTORS ARE 2N1305
2. ALL NPN TRANSISTORS ARE 2N3711
1. ALL DIODES ARE NLS 5003-002
NOTES, UNLESS OTHERWISE SPECIFIED.



PREAMPLIFIER
PREAMPLIFIER POWER SUPPLY
INPUT SWITCHING
ALL SHIELDS CONNECT TO GUARD BOX
INPUT
HI
LO
P1
P2
REF. 50-194
Q3 2N1540
Q4 2N1701
K7 COIL
C4 .33UF.
C3 .5UF.
C5 5UF
C6 5UF
C1 1000UF/50V
R4 10K
A.C. CONVERTER
DECADE FIVE
AUTO RANGE DELAY & DRIVER
DECADE FOUR
AUTO RANGE COUNTER
DECADE THREE
PRINT CONTROL
DECADE TWO
LOGIC
DECADE ONE
AMPLIFIER
D.V.M. POWER SUPPLY
BOTTOM VIEW
SHIELDED CABLE
J2 (INPUT)
J3 (EXTERNAL REFERENCE)
C7 .22UF/100V.
R5 100K
+24
+16
+12
GRND
T1
CHASSIS GROUND
27VAC
58VAC/CT
19VAC
Q1 2N3235 REF. 50-194
Q2 2N1540 REF. 50-194
REF. 50-194 R1 (SENSITIVITY)
REF. 50-127 (PREAMP ZERO ADJUST)
R2 50K
R3 125K
S1 (FUNCTION SWITCH)
RATIO
D.C.
A.C.
KΩ
REMOTE
50-303 RELAY BOARD ASS'Y.
50-303 RELAY BOARD ASS'Y
S3 (POWER SWITCH & PRINT CONTROL)
OFF
STANDBY
ON
AUTO
CONTINUOUS
MANUAL
CHASSIS GROUND
S2 (RANGE SWITCH)
.1
1
10
100
1000
10,000
AUTO
REMOTE
S4 (FILTER SWITCH)
IN
OUT
FRONT

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A	BEFORE 5020-819	REVISED & REDRAWN	JAC 1/11/66	R.T.W. 1-12-66
	B	5020-819 & ON	ADDED 50-303 RELAY BOARD & ASSOC. WIRING.	2-11-66 JAC	3-2-66 R.T.W.
	C	ALL	R2(50K) WAS R3 R3(125K) WAS R2 INCORP E.O. 1 OF CHG "A"	3-21-66 JAC	3-21-66 R.T.W.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-194	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ±.010
ANGLES ±0° 30'
FRACTIONS ±1/32

MATERIAL

CONTR. NO.
DRAWN J.A. COMBS 10-27-65
CHECK [signature] 11-12-65
APPR R. Warner 11-15-65
RELEASE DATE 11-16-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

MAIN BOARD SCHEMATIC

MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-244

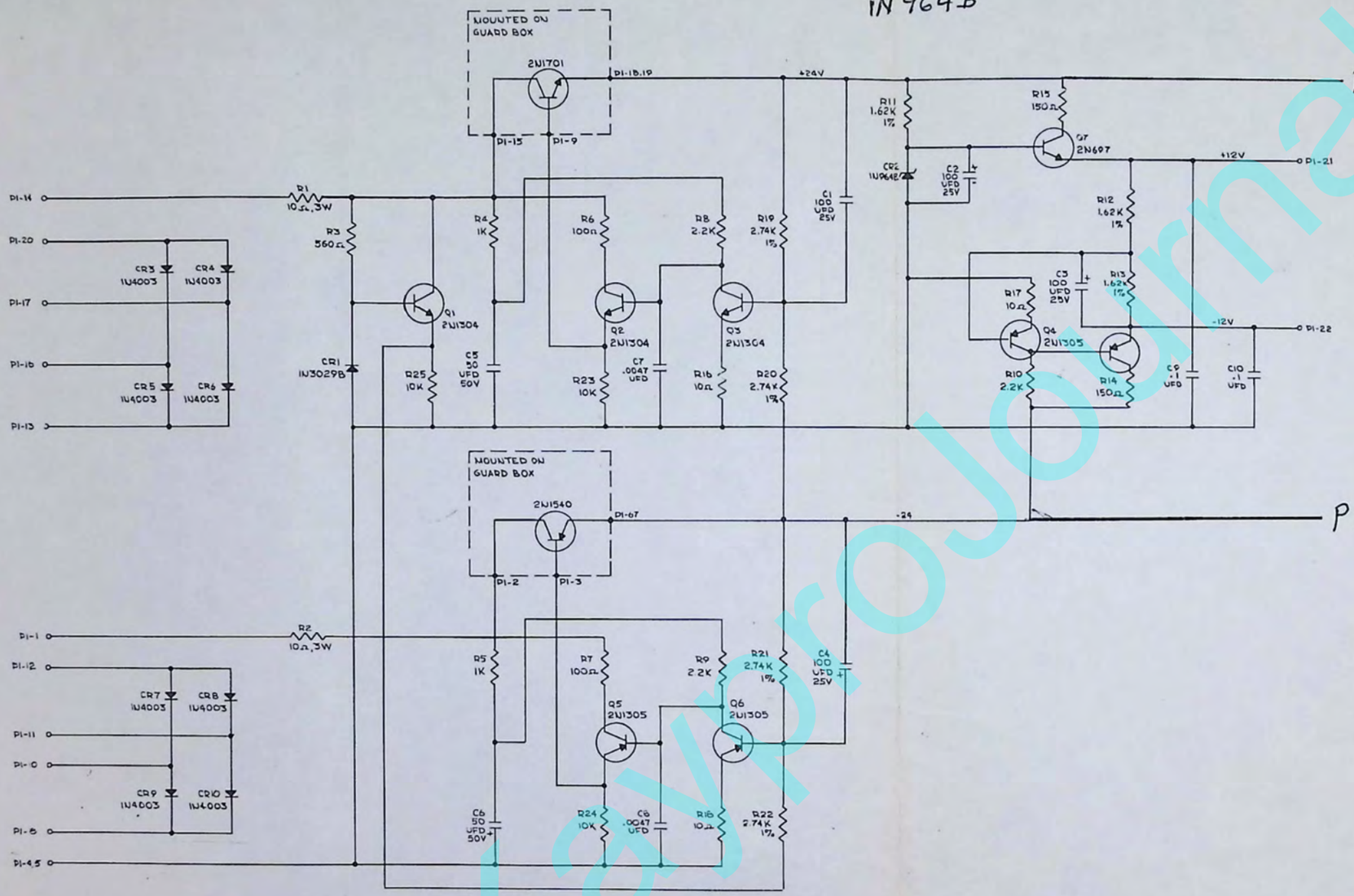
SCALE | WEIGHT | SHEET 2 OF 2

Kaypro Journal

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
O/A	B	ALL	REDRAWN LAG (PP) 2-21-66	4-1-66	R.T.W.

13 VOLT .4W

IN 964B



P1-18,19 +24v

P1-6,7 −24v

50-122

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED	CONTR. NO.		
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 ANGLES ± 0° 30' FRACTIONS ± 1/32	DRAWN	M. BAGULA	7-26-65
	CHECK	L. KNAPIK	7-26-65
	APPR	R.T. WARNER	7-26-65
MATERIAL	RELEASE DATE	9-28-65 E	

50-193	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

+24 AND -24 VOLT SUPPLY SCHEMATIC PREAMPLIFIER AND COUVERTER

MODEL 5020

SIZE	CODE IDENT NO.	
D	03626	50-250
SCALE	WEIGHT	SHEET 2 OF 2

50-250 SH 2

Kay Project Journal

ERRATA

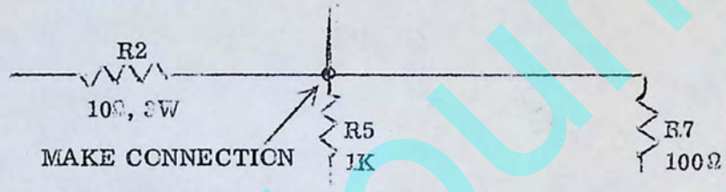
MODEL 5020 DIGITAL VOLTMETER INSTRUCTION MANUAL

1. Replace page 3-7 with revised page 3-7 located in back of manual.

2. Make the following corrections to schematic 50-250:

   a. The transistor to the right of Q4 is Q8, 2N1183.

   b.

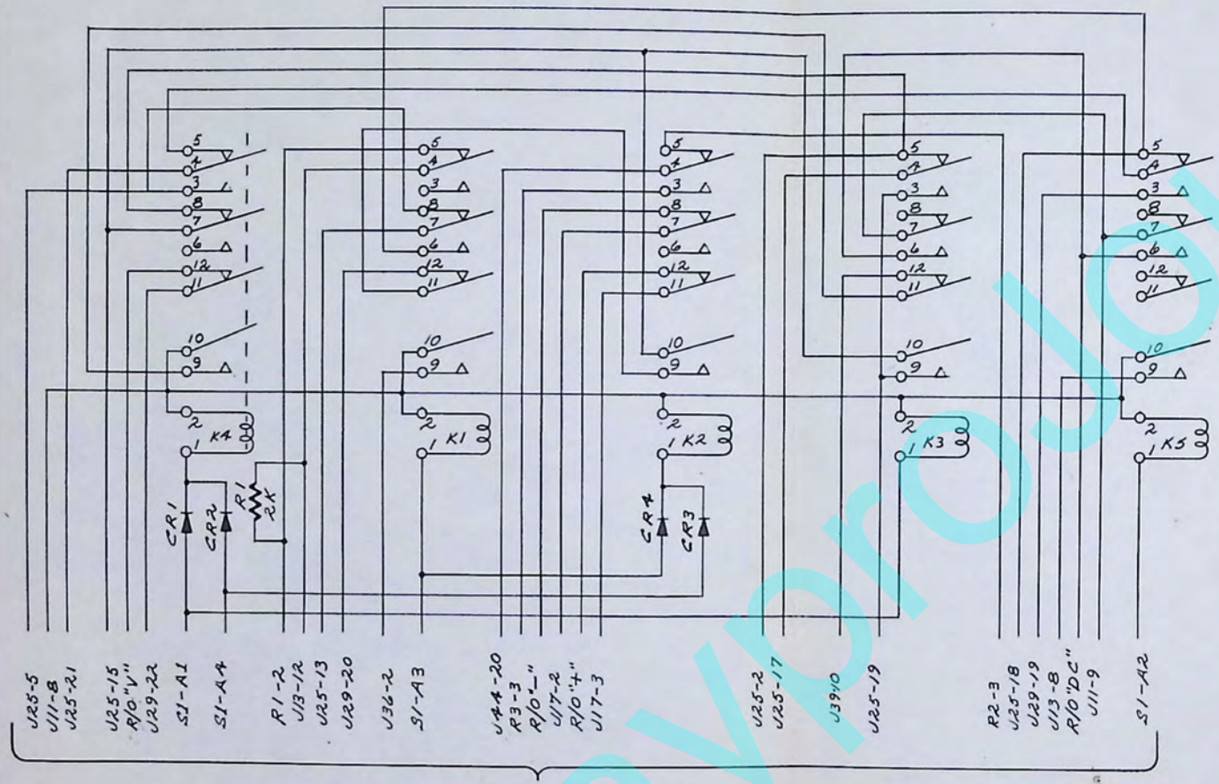


   c. NOTES: Unless Otherwise Specified

      1. All Resistors are 1/2W, 5%.

Kaypro Journal

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED



REFERENCE 50-244 SCHEMATIC
FOR HARNESS TERMINATION

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED		CONTR. NO.	
DIMENSIONS ARE IN INCHES TOLERANCES ON		DRAWN	J.A. COMBS 2-10-66
DECIMALS ± .010	ANGLES ± 0° 30'	CHECK	
FRACTIONS ± 1/32		APPR	R. Warren 2-11-66
		RELEASE DATE	2-24-66

MATERIAL

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
FUNCTION RELAY BOARD
MODEL 5020

SIZE	CODE IDENT NO.	
C	03626	50-303

SCALE | WEIGHT | SHEET 2 OF 3

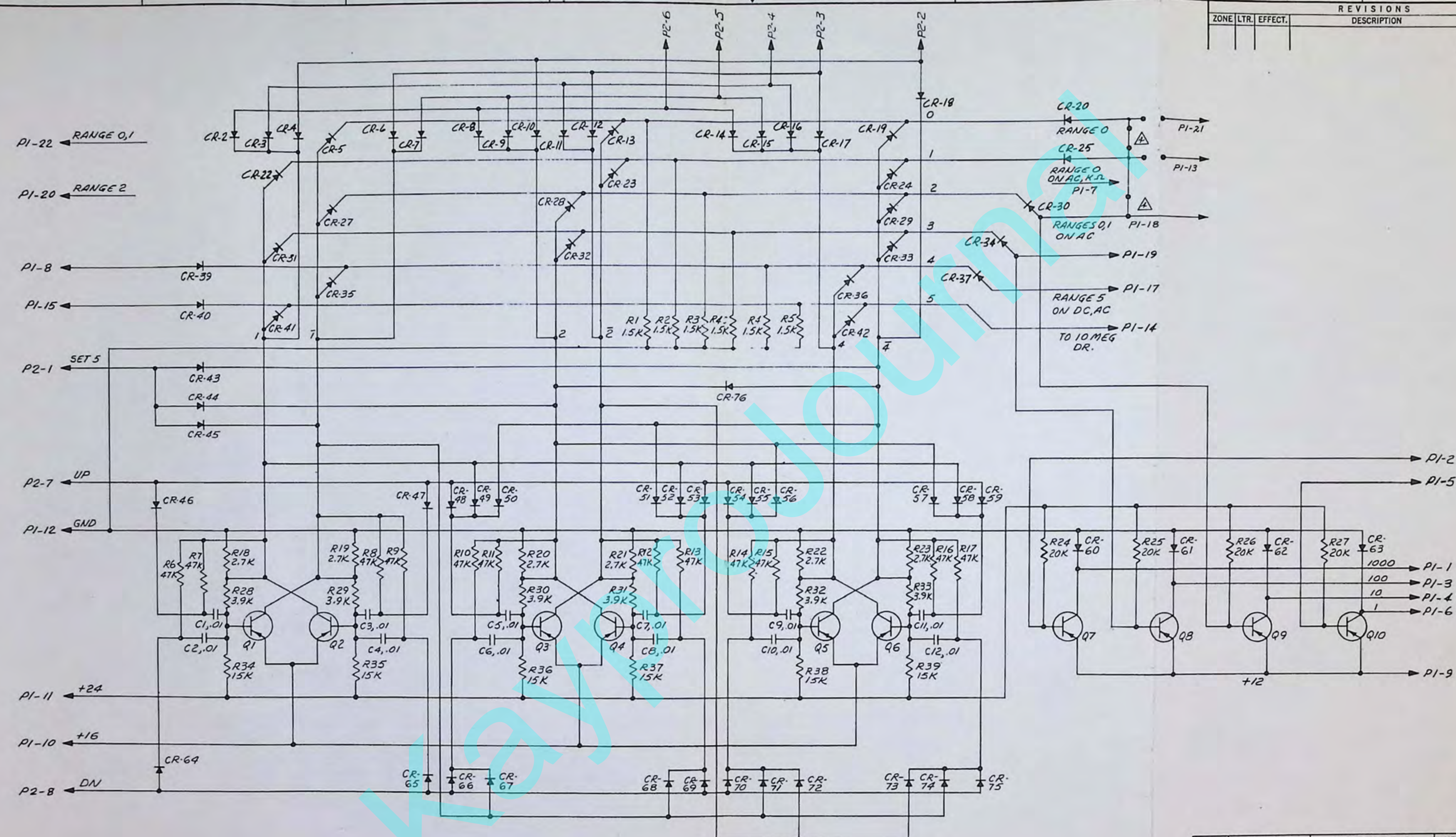
50-194	50-193	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

NOTES
1. THIS DWG EFFECTIVE 5020.819 & SUB.

50-303

Kaypro Journal

ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED



NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL TRANSISTORS ARE 2N1305.
2. ALL DIODES ARE TYPE UG 315 (5003-002).
3. ALL RESISTORS ARE 1/2W 5%.
4. ADD JUMPERS. AS SHOWN (PROVIDED FOR ON 50-235 P.C. BD, CHG. B.)
5. LESS AC, OHMS, PREAMP (ONLY ONE RANGE OF RATIO IN THIS VERSION.)

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
50-336	50-336	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

CONTR. NO.		
DRAWN	W.A. COMBS	12-20-65
CHECK	[illegible]	12-28-65
APPR	R. Warner	12-21-65
RELEASE DATE	1-5-66	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

AUTO-RANGE COUNTER
MODEL 5020

SIZE D | CODE IDENT NO. 03626 | 50-341 | REV.

SCALE | WEIGHT | SHEET 2 OF 3