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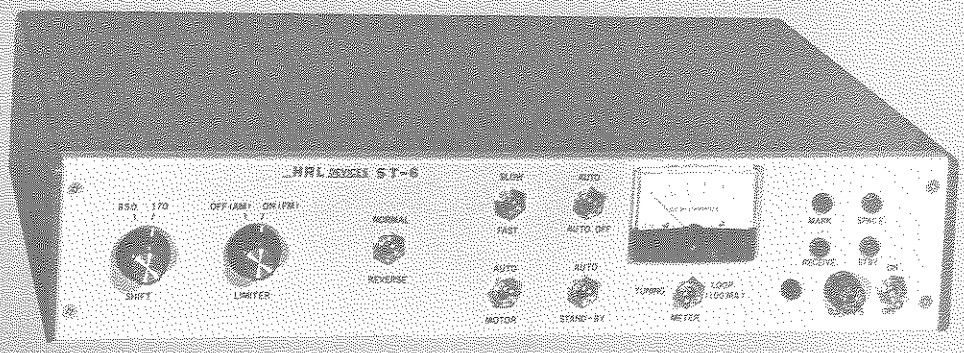
HAL ST-6 RTTY TERMINAL UNIT



INSTRUCTION MANUAL

HAL COMMUNICATIONS CORP.
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QUALITY COMMUNICATIONS EQUIPMENT

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WARRANTY

HAL Communications Corp. warrants that the HAL Communications Corp. factory-wired ST-6 Demodulator shall be free of defects in materials and workmanship under normal use and service for a period of one year. Should such defects occur within the warranty period, notify HAL Communications Corp. promptly. The warranty period is measured from the date of the original invoice to the postmark-date of your notification letter. Do not return your unit to the factory for repair or adjustment until you have received written return authorization.

In the case of ST-6 Demodulator Kits, this warranty applies only to the parts supplied in the kit and does not apply to any wiring or components which, in the judgement of HAL Communications Corp., were damaged by incorrect use or construction on the part of the kit builder.

This warranty is and shall be in lieu of all other warranties, whether expressed or implied, and of all other obligations or liabilities on the part of HAL Communications Corp. resulting from the installation or use of this demodulator.

The foregoing warranty is completely void on all ST-6's which have been repaired by individuals other than HAL Communications Corp. personnel, those which have been damaged, abused, modified, improperly installed, or tampered with, and those which have been subjected to improper voltages or currents.

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1. INTRODUCTION

The model ST-6 RTTY Demodulator is a high-performance, all solid-state demodulator for the reception of radio teleprinter RTTY signals. The ST-6 features separate pre-limiter bandpass filters and linear discriminators for reception of the standard 170 Hz and 850 Hz frequency shifts. The input limiter stage is capable of a dynamic range exceeding 80dB with negligible zero-level cross-over distortion. An automatic control holds the ST-6 in the mark condition when non-RTTY signals (such as voice, cw, or noise) are received. An anti-space control protects against continuous signals on the space frequency. The motor-control circuit switches the teleprinter motor on automatically when RTTY signals are detected, allowing full unattended autostart control of the teleprinter for monitoring net frequencies. The low-voltage supplies of the ST-6 are electronically regulated and a 175 volt, 60 ma loop supply is included in the demodulator. Normally supplied for use with 120VAC, 50-60 Hz power sources, the ST-6 can be modified for use with 240 vac power systems by rewiring connections to the power transformer. The complete demodulator is housed in a 3 3/4 X 17 X 12 cabinet and weighs 12 lbs (18 lbs shipping weight). Complete specifications are listed in the following section.

The manual contains complete operating instructions and a guide to servicing your ST-6. The construction procedure for ST-6 kits is also included. Whether your ST-6 comes in kit form or factory assembled, it will be worth your time to read this manual carefully before operating your demodulator.

2. SPECIFICATIONS

Input Frequency Range: 2000 - 3000 Hz

Input Impedance: 500 ohms, unbalanced

Input Bandpass Filter Bandwidth(-3dB): 1100 Hz (850 Hz shift)
260 Hz (170 Hz shift)

Input Limiter Stage Performance:
(Measured with a 2125 Hz signal on input of demodulator)
Limiting threshold: 1.0 mV peak-to-peak (limiter switch in "ON(FM)" pos.)
150 mV peak-to-peak (limiter switch in "OFF(AM)" pos.)

Maximum Signal Input: 10V Peak-to-peak (either limiter switch pos.)

Discriminator Performance:

Nominal Filter Center Frequencies:

850 Hz Shift: Mark - 2125 Hz ± 5 Hz
Space - 2975 Hz ± 5 Hz

170 Hz Shift: Mark - 2125 Hz ± 3 Hz
Space - 2295 Hz ± 3 Hz

Discriminator Filter Bandwidth (all filters - 3dB): 140 Hz (850 shift)
70 Hz (170 shift)

Minimum Detectable Frequency Shift: 850 Hz - 50 Hz
170 Hz - 10 Hz

Maximum Detectable Frequency Shift: 850 Hz - 1100 Hz
170 Hz - 350 Hz

Note: The linear discriminator in the ST-6 allows reception of shifts other than the standard 850 Hz or 170 Hz shifts, but the received audio tones must be centered in the bandpass of the discriminator selected; i.e., for shifts between 1100 Hz and 200 Hz, the tones should be centered on 2550 Hz; for shifts between 200 Hz and 10 Hz, the tones should be centered on 2210 Hz. Autoprint or autostart operation is restricted to shifts within the autostart bandwidth given below.

Autoprint Performance

Autostart Response Time: Slow - 3.5 sec
Fast - 1.5 sec

Motor Control Delay Time: 30 sec. ± 10 sec.

Autostart Bandwidth: 850 Hz - 140 Hz
170 Hz - 70 Hz

Autoprint Operation

When no RTTY signals are recognized the autostart system places the demodulator in a standby mode with the printer motor and loop current defeated. Within 3.5 sec. (or 1.5 sec. in "Fast" mode) after recognition of a valid RTTY signal, the autostart system energizes both the motor and loop supply and allows the demodulator to key the loop. Within 3.5 sec. (or 1.5 sec.) after loss of signal, the system is placed in a "mark-hold" condition with loop supply and printer motor energized but with the loop keying stage defeated. If a signal is not recognized within a nominal 30 seconds, the printer motor is shut off and the loop current is interrupted to minimize standby power consumption. The autostart activation is sensed from the discriminator stage and is therefore frequency sensitive. As noted above, the autostart system is designed to work primarily with signals of standard frequency shifts (850 and 170 Hz) and should be defeated when print of non-standard shifts is desired.

Lowpass Filter Stage:

Cut-off Frequency: 27 Hz (60 wpm, 45 baud)
45 Hz (100 wpm, 75 baud)

The low-pass cut-off frequency is normally set at the factory for 75 baud to permit use of the ST-6 at speeds of 100 wpm.

Automatic Threshold Control:

This system allows copying of signals on a mark-only or space-only basis by providing automatic zero threshold correction. This circuitry functions best when the demodulator is used in the "FM" mode (limiter on) and offers outstanding performance with a relatively simple and economical circuit.

Outputs:

LOOP: Internal 175 volt, 60 ma loop supply; Printer selector magnets and transmitter contacts wired in standard series loop, connected to ST-6 with a ¼", 2-circuit ("stereo") phone jack. When the "Auto" - "Standby" switch is in the "Standby" position, the keyer stage of the ST-6 is defeated and teleprinters can be used in "local-loop" configuration. Grounding the "remote" jack also places the demodulator in "Standby" condition for local loop operation.

FSK: A low-voltage keying source is provided at the FSK jack for driving FSK or AFSK keyer stages for transmission of RTTY signals. This feature is normally used in local-loop mode when transmitting (ST-6 in "Standby" mode), but the keying voltages are available at all times allowing the ST-6 to be used in repeater operations.

This output is EIA (RS-232) compatible and is used to drive the HAL RVD-1002 Visual Display system.

Nominal Voltages: Mark: -15 V (into a 1K load)
Space: +15 V (into a 1K load)

KEY: A telegraph key may be connected to the key jack to provide narrow-shift cw identification when transmitting. When used to key a FSK system, the amount of cw frequency shift is controlled by the "CW Shift" potentiometer.

SCOPE: A two-circuit, ¼" jack is provided for connection to an external oscilloscope for use as a tuning indicator. Since a tuning meter is normally furnished with the ST-6, use of an oscilloscope is optional. Approximately 4 volts peak-to-peak (at the center frequency of each discriminator filter) is furnished to a 1 meg ohm oscilloscope input.

Printer:

A three-wire, U-ground AC receptacle is furnished on the rear panel to supply power to teleprinter motors. This output is controlled by the autostart circuitry. Total load should not exceed 10 amperes. Note: Fuse protection for this putput is not provided in the ST-6 - each teleprinter should be fused.

Miscellaneous Data:

Fuse Protection:

AC Power Input - 0.5 amp. panel - mounted fuse holder

+ 12 V Supply - 0.25 amp, mounted on power supply circuit card

- 12 V Supply - 0.25 amp, mounted on power supply circuit card

Loop Supply - 0.1 amp time delay, mounted on power supply circuit card

Power Requirement:

120/240 VAC, 60 Hz (normally provided for 120 VAC unless otherwise specified - 240 V plug to be supplied by user)

Power Consumption: 7 watts maximum "Standby" configuration (loop off)
12 watts maximum "Receive" mode, loop on.

Voltage Tolerance: ± 10%

Mechanical:

Size: 3 3/4" high X 12" deep X 17" wide

Style: Table-top cabinet or standard 19" relay-rack mounting.

Weight: 18 lbs., shipping; 12 lbs. net.

Color: Light gray front and rear panels with dark gray wrinkle finish top, bottom, and side panels.

3. OPERATION

The ST-6 is one of the most elaborate RTTY terminal units offered to amateur radio operators. It incorporates many features which when properly understood and applied, can add much to your enjoyment of RTTY operation. The following discussion is a general guide to the use of these features and should be particularly helpful if you have not had experience with the advanced autostart circuitry first introduced in the TT/L and TT/L-II RTTY terminal units. As you gain familiarity with the ST-6, you will probably develop your own preferred techniques for operation.

Tuning a Radio Teleprinter Signal for Optimum Performance

Two different forms of tuning indicator are provided for in the HAL ST-6: the familiar crossed-ellipse oscilloscope display and a tuning meter. The meter is included in the ST-6; a jack on the rear panel is provided for connection to an external oscilloscope. Both techniques provide reliable indications and are considerably easier to use than describe!

When using the oscilloscope as a tuning indicator, a portion of the signal at the mark filter of the discriminator is coupled to one of the inputs of the scope (usually the horizontal input) and the signal at the space filter is coupled to the other scope input (vertical). When the receiver is properly tuned, the mark signal will produce a line or ellipse in the horizontal plane, and the space signal a line or ellipse in the vertical plane. If the received signal has the same shift as the TU discriminator, the two displays will be maximum amplitude at the same frequency on the receiver. The receiver is therefore tuned for a maximum in both lines. The discriminator in the ST-6 uses fairly broad bandwidth tuned circuits to achieve a linear response and therefore the scope patterns will be ellipses instead of lines. When tuning, adjust for maximum amplitude of the major axis of each ellipse and ignore the minor axis or width of the ellipse. The ellipses for the 170 Hz filters will be wider than those for 850 Hz shift.

Use of the tuning meter is straightforward, although it will require some time for RTTY enthusiasts familiar with the scope display to adapt to this. The signals from both the mark and space filters of the discriminator are detected and combined to produce a DC voltage that is positive for either tone (the "plus-plus" voltage). The voltage on the "plus-plus" line is therefore a direct indication of how close the received signal is to center frequency of each filter. This voltage will be a maximum when the received mark tone is correctly centered on the mark filter in the discriminator; the same applies to the space tone.

The discriminators of the ST-6 are preadjusted so that the maximum voltages from the space and mark filters are equal. Therefore, if a signal is tuned in so that both its mark and space signals are centered on the ST-6 discriminator filters, the voltage on the "plus-plus" line will be a maximum for either tone, and in fact, will not change as the signal goes from mark to space and back. This "plus-plus" voltage is indicated on the tuning meter.

Correct tuning on the meter is therefore indicated by maximum deflection that does not vary as the incoming signal switches back and forth between mark and space.

Now consider what the meter indication will be if the signal is not tuned correctly; if tuning is set so that more output occurs from one filter than the other, the tuning meter may not read maximum deflection and will definitely flicker when the signal goes from mark to space. If no RTTY signal is present, the tuning meter will not read as high and will flicker widely on the incoming noise (for the present discussion, any interference such as CW or SSB is also considered to be noise).

If the received signal is transmitted with a frequency shift somewhat different from the standard 850 or 170 Hz shifts provided for in the ST-6, it will be impossible to adjust the receiver for maximum deflection of the meter with no flicker, since it is impossible to get both tones centered on both filters at the same time. However, the ST-6 will very reliably copy shifts considerably narrower than the design center by straddle-tuning the signal. This is the primary reason for use of the linear discriminator.

When straddle-tuning a signal, adjust receiver tuning for minimum flicker of the tuning meter. This receiver setting will not produce maximum deflection, but the demodulator will still perform properly (except for the autostart circuit, as will be discussed later). The tuning meter driver circuit is adjusted so that a RTTY signal with proper shift and correctly tuned will produce a meter deflection of 0.7 ma in the 850 Hz shift mode and 0.6 or higher in the 170 Hz mode.

With either type of indicator it is best to defeat the autostart circuitry when tuning by placing the "AUTO - AUTO OFF" switch in the "AUTO OFF" position. Although the ST-6 will reliably print very narrow shifts, the autostart imposes rather tight tolerances on the shift to minimize unwanted turn-on's. It is also best to tune in stations with the limiter set to "ON(FM)" and then go to limiterless operation "OFF(AM)" if necessary to copy through interference.

The ST-6 Autostart System

The autostart system in the ST-6 is considerably more complex than those circuits normally added to terminal units to simply turn the printer motor on and off. Two independent functions are controlled in the ST-6 - the keyer stage operation and the power to the printer motor. Control of the keyer stage provides a fairly rapid means of placing the printer in mark-hold condition while keeping the motor on for a predetermined length of time.

This feature is particularly convenient when in QSO, since the machine prints little garble between the end of one station's transmission and the beginning of another's. Properly adjusted, the autostart is even immune to the station's CW identification (if narrow-shift CW ID is used).

If a RTTY signal is not received within 25 to 50 seconds (the exact time may vary between units because of electrolytic capacitor tolerances) after a station ceases transmitting, the printer motor is shut off. The keyer and

printer motor are re-activated automatically whenever a signal is received (within 3-4 seconds in "SLOW" mode and approximately 1 second in "FAST" mode).

The autostart circuit is triggered from the same "plus-plus" line used to drive the tuning meter. A threshold level adjustment (the trim-pot on circuit board 4) presets the voltage required to trigger the autostart. Since the amplitude of the "plus-plus" voltage is proportional to frequency, this adjustment also sets the shift-frequency tolerance of the autostart trigger point. If the trigger threshold is adjusted close to the maximum voltage available from the plus-plus line, the autostart will trigger only on strong signals with exactly 850 Hz shift. If it is adjusted too far the other way, the autostart will never deactivate.

The autostart trigger threshold is normally adjusted to trigger on any signal that gives a tuning meter indication of 0.6 ma or higher, but you may wish to experiment with this adjustment to determine the trigger level you prefer. Set at the 0.6 ma level, the autostart will respond to signals within approximately $\pm$100 Hz of 850 Hz shift and $\pm$45 Hz of 170 Hz. This tolerance becomes considerably tighter for weak signals.

An additional feature of the motor control circuit is that when power is removed from the printer motor, the loop current of the ST-6 is removed by shorting the base of the keyer transistor to ground. This reduces the power consumption and heat generated during stand-by periods.

There are four toggle switches and two pilot lamps which control and monitor the operation of the ST-6 autostart circuits:

SLOW - FAST: This switch controls the turn-on time of the autostart system. In the "SLOW" position a RTTY signal must be present for approximately 3 to 5 seconds (5 or 6 characters) before the autostart will actuate. This delay provides fairly good protection against false turn-on's. The "FAST" position allows the TU to activate in less than a second, particularly convenient for fast-break operation. The motor relay and therefore the printer motor are held on whenever the switch is in the "FAST" position.

AUTO - AUTO OFF: This switch defeats the autostart circuitry for tuning or for full manual operation.

AUTO - STANDBY: In the "STANDBY" position, the ST-6 is locked in a mark-hold condition with the printer motor on. Received signals will not be printed but the tuning indicators will still function. This control is quite convenient for use when transmitting. It is paralleled by the remote jack on the rear panel so that it may be connected to station transmit-receive control circuitry.

AUTO - MOTOR: In the "MOTOR" position, the printer motor control feature is locked out and the printer motor is held on.

RECEIVE: This pilot lamp will light whenever the autostart has activated the TU for reception of RTTY signals.

STBY: This pilot lamp lights whenever the autostart is not active and the printer is being held in the mark-hold condition or when the motor has been turned off. Note: Both the "RECEIVE" and "STBY" lamps will be lit whenever the "AUTO" - "STAND-BY" switch is in "STAND-BY" position or when the remote jack is shorted. This provides a positive indication that the TU is in the standby mode and serves as a warning that the TU will not receive signals.

As discussed previously it is usually easiest to tune the receiver with the autostart defeated until you have become familiar with autostart operation. The time delay generated by the autostart, particularly in the "SLOW" mode, can be particularly disconcerting if you expect to get print-out immediately upon achieving correct tuning. Autostart operation is most useful for monitoring net frequencies and during QSO's, particularly in round-table discussions.

The ST-6 Anti-space Circuit

The ST-6 includes a circuit that prevents the printer from "running open" if a continuous space tone is received. The circuit senses the length of time that a space signal is present at the output of the slicer stage. If it exceeds the maximum possible time permitted by the Baudot (RTTY) code (132 ms for a blank key), the keyer stage is placed in mark-hold condition, as in autostart operation. Also, the output of the anti-space circuit is coupled to the autostart circuit so that the motor is shut-off if the space condition persists. The anti-space mark-hold feature is always active in the ST-6.

Other Controls

The functions of the remaining controls on the ST-6 are as follows:

SHIFT (170 - 850): Either of the two standard RTTY shifts is selected with this switch. It connects the correct input filter, limiter, discriminator, and low-pass filter section for the shift to be demodulated. It also switches the plus-plus line from one discriminator to the other, and the AK-1 AFSK oscillator, if used. On demodulators with the 3-Shift option, a third switch position selects 425 Hz shift.

LIMITER (OFF(AM) - ON(FM)): The input amplifier can be switched from limiting operation to a linear amplification mode with this switch to allow limiterless reception, sometimes useful in copying weak signals through interference. The switch controls the limiter stages for both 170 and 850 Hz shifts. The autostart circuitry is automatically defeated when the switch is in the "OFF(AM)" position.

NORMAL - REVERSE: This switch reverses the input to the slicer stage for copying signals with reversed shift. For reception of HF FSK signals in the "NORMAL" position, the receiver should be used in the lower sideband mode. VHF AFSK signals should copy in the "NORMAL" position if the convention of low-tone mark is followed.

METER (TUNING - LOOP (100 ma)): In the "TUNING" position, the meter functions as a tuning meter, as discussed previously. In the "LOOP" scale of 0-100 ma, it monitors the loop current.

MARK - SPACE: These two neon pilot lamps indicate the condition of the loop circuit. They normally flash when receiving RTTY signals. They are particularly good for impressing visitors to the shack, although some people have used them for tuning indicators.

ON - OFF: This switch controls all power supplies, including the loop supply. The printer motor power is not directly controlled by this switch but cannot be activated with the ST-6 off, since the motor relay controls the printer motor.

0.5 AMP: This is the AC fuse for all power supplies in the ST-6. It does not protect the printer motor since the motors are usually fused in the printer housing itself.

CW SHIFT: When using the Mainline FSK keyer system, this potentiometer adjusts the shift for CW identification.

LOOP CUR.: This rear-panel rheostat adjusts the loop current. It should normally be set for 60 MA unless your printer requires a non-standard loop current.

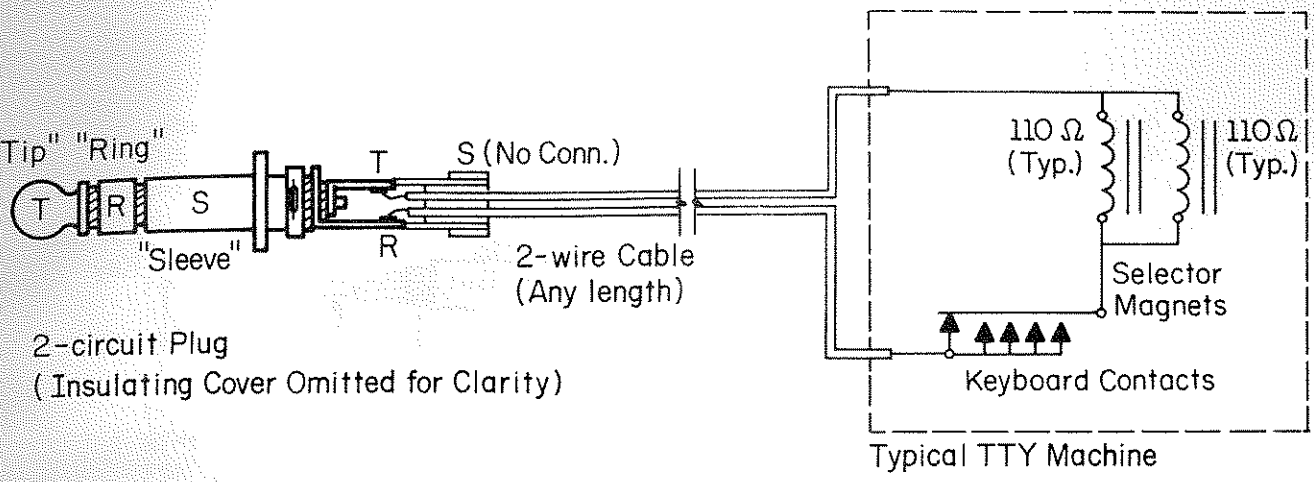
External Connections

The following rear-panel connections are provided on the ST-6:

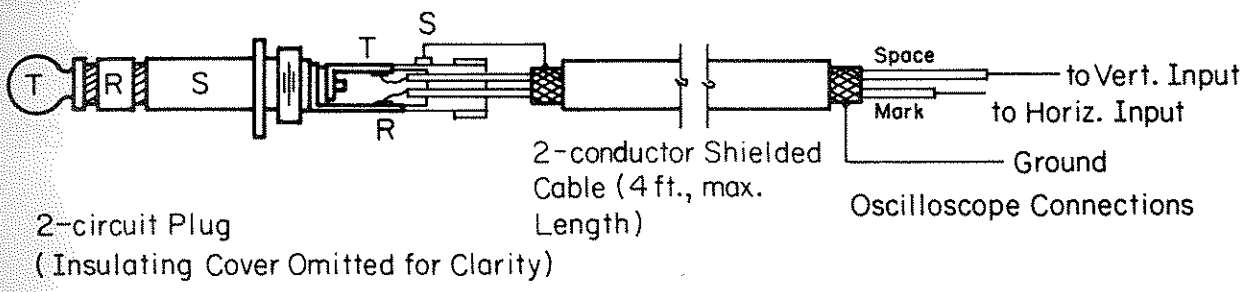
AF IN: The audio output from the station receiver should be connected to this jack. Use the receiver's 500 ohm audio output if at all possible. A low impedance output will work, but will reduce the potential limiting by some 30 dB. Voice-coil to 500 ohm line transformers are available at reasonable cost and are a worthwhile investment. The receiver volume need not set very high, particularly if the 500 ohm output is used. See Figure 1 for connection details.

SCOPE: A two-conductor plug is provided for connection to this jack. To produce the scope display discussed previously, connect the scope horizontal input to the tip of the jack and the vertical input to the small sleeve. The scope ground should be connected to the long sleeve. Note: since the ST-6 is a semiconductor TU, the oscilloscope output voltage is considerably less than that developed in tube-type terminal units. Higher gain will be required in the oscilloscope to produce a useable pattern. See Figure 1 for typical connections to the scope jack.

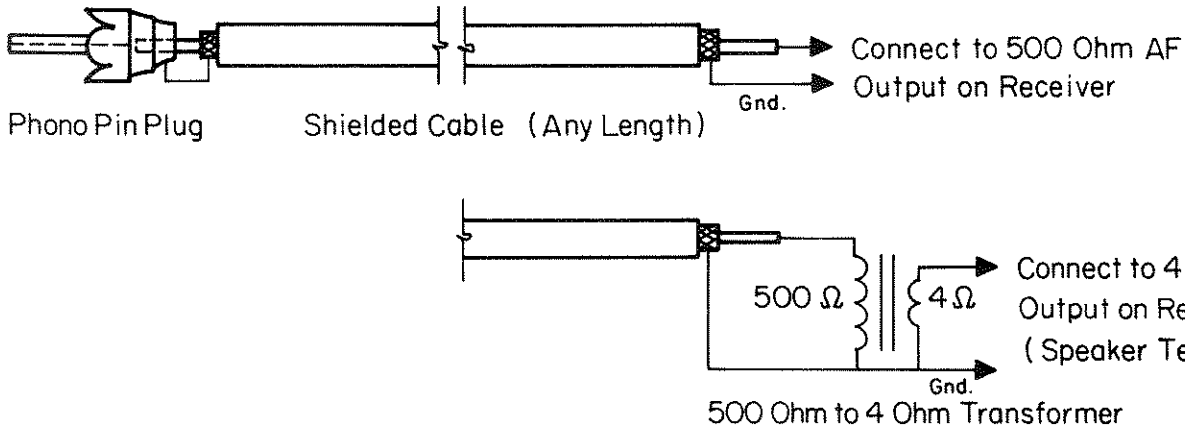
REMOTE: An external switch or set of relay contacts can be connected across this jack to provide remote standby control. The ST-6 will perform normally with the jack open-circuited and will switch to the standby mode when the jack is shorted. See Figure 2 for plug wiring details.



Connections to Printer Jack



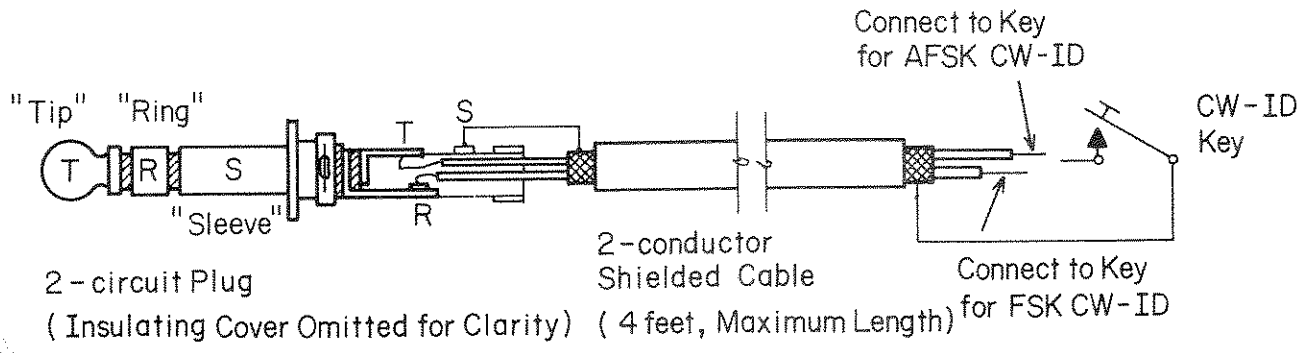
Connections to Scope Jack



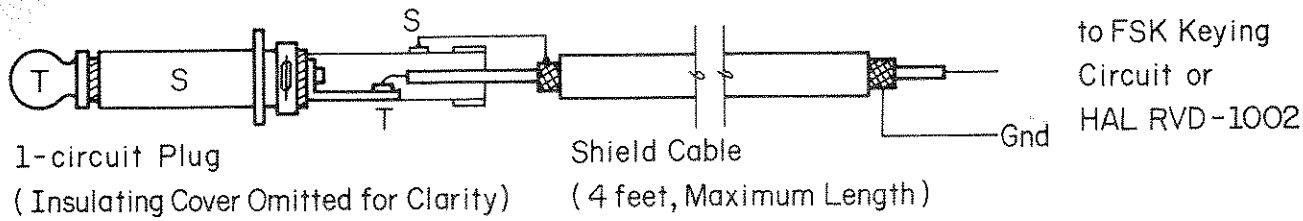
Connections to Audio Input of Demodulator

Figure 1

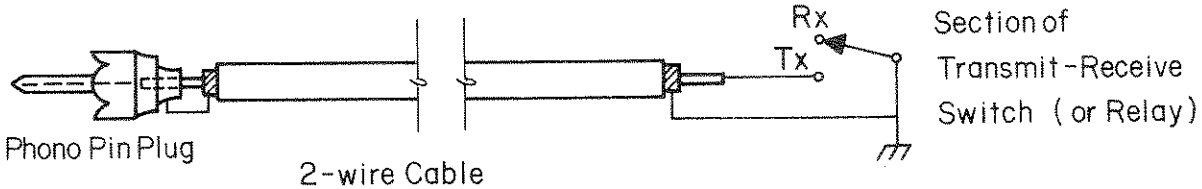
Plug Connections for Printer, Scope, and AF Input



Connections to CW-ID Key Jack



Connections to FSK Jack



Connections to Remote Jack

Figure 2

Plug Connections for Key, FSK, and Remote Jacks

KEY: When using the Mainline FSK system, a hand key can be connected to this jack for narrow-shift CW identification. The key should be normally open:guard against accidential closure of the key with a shorting-bar. A two-conductor jack is provided so that CW ID can be set-up for either AFSK with the AK-1 or FSK using a Mainline FSK system. See Figure 2 for connection details.

FSK: The keying voltages provided at this jack are fully compatible with the Mainline FSK keying system. For a full discussion of an FSK system, see Hoff's article in May, 1965 QST (p. 16). When the ST-6 is used with the Hal RVD-1002 RTTY visual Display system, the FSK jack on the ST-6 is connected to the DATA Input jack on the RVD-1002. See the RVD-1002 manual and Figures 2 and 3 for further details.

PRINTER: Connect the RTTY printer to this jack. To use the Mainline FSK system, the printer and keyboard should be connected in series and the loop connected to this jack. The normal connection for older model 15 and 19 machines is to wire the selector magnets in parallel and the combination in series with the keyboard contacts. For other printers consult the manual for proper connections. In no case should an external loop supply be connected to the ST-6, as the loop supply is built in. Also, no portion of the loop should be connected to electrical ground. NOTE: To provide greater operator safety, a two-conductor jack (and mating plug) are provided for the connection to the loop. The printer & keyboard are connected to the "tip" and "ring" of the plug, with no connection to the "sleeve." This allows the frame of the jack to be grounded, eliminating the shock hazard which results from insulating a standard ¼" one-circuit jack. Cables from the printer & keyboard should be re-wired for this jack as illustrated in Figure 1.

Preparation of the various cables & connectors is illustrated in Figures 1 and 2 and typical interconnections with other equipment is shown in Figure 3.

MOTOR: The printer motor is connected here for autostart control of the motor. Note that a three-conductor grounding socket is provided. It is strongly recommended that the printer motor be equipped with a grounding power cord and that the frame of the printer be firmly attached to a good electrical ground.

AC Power Cord: A standard three-wire grounding power cord is furnished with the ST-6 for connection to 115/120 V, 60 Hz power mains. ALWAYS OPERATE THE ST-6 WITH AN ADEQUATE GROUND. FAILURE TO GROUND THE UNIT OR DEFEAT OF THE POWER CORD GROUND VOIDS THE WARRANTY. When operating the ST-6 from a 230 V line, be sure that the transformer primaries are properly connected and that the proper plug is installed on the power cord. As for 115 V operation, the ST-6 should be properly grounded.

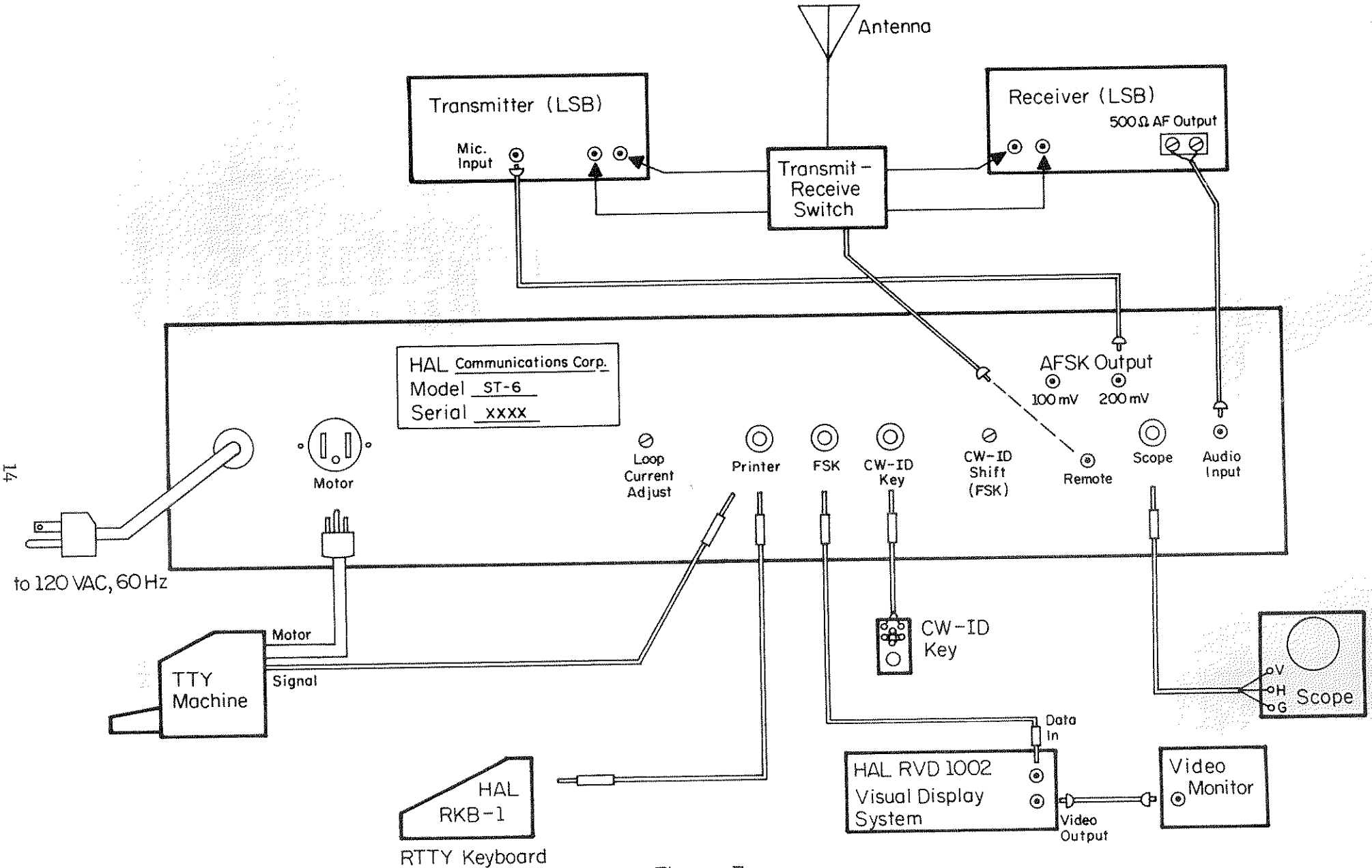


Figure 3

Interconnections from the ST-6 to Other Equipment

4. ST-6 KIT CONSTRUCTION

The HAL Communications Corp. ST-6 parts kit furnishes the experienced RTTY enthusiast with quality parts at a reasonable price for the construction of the ST-6 RTTY Terminal Unit described by Hoff in September and October, 1970, RTTY Journal, and January and February, 1971, HAM Radio. To provide for all features of the terminal unit, a set of seven printed circuit boards and associated components are furnished. This is not a kit in the usual sense; step-by-step instructions are not furnished. It is assumed that the builder has experience in electronic construction and can build from schematics and pictorial layouts with a limited amount of suggestions. This is NOT a kit for beginners to undertake! A few helpful hints regarding circuit board construction in particular are included, but a number of details are left to the inventive mind of the builder.

The parts for the ST-6 have been packaged with all resistors in one sack, all capacitors in another, etc. Upon receipt of the parts kit, the builder should unpack ALL components and separate them according to the individual parts lists for each circuit board. Notify HAL Communications Corp. immediately of any shortages so that we may promptly rectify the problem. All components are covered by the standard HAL Communications Corp. one-year warranty. If a failure occurs, please write giving full details. DO NOT ship any item back without prior notice to HAL Communications Corp.

The following pages of construction techniques are a collection of hints for the construction of the circuit boards and placement of parts and boards in the cabinetry. Please read the entire manual before starting construction.

Construction of Circuit Boards

The pictorial layouts show the placement of the components on the boards. The Molex Soldercon terminals for the integrated circuits should be inserted and soldered to the board first. The Soldercons are supplied in 7 pin strips, two per integrated circuit. DO NOT remove the individual pins before soldering the strip in place. Insert all Soldercon strips at the appropriate positions and solder them in place. Use great care in soldering to prevent solder from flowing inside the pins and from bridging across the closely spaced pads on the circuit board.

After all the Soldercons for a given board have been soldered in place, the "carrier" strips are removed from between the pins by gripping the carrier strip firmly with longnose pliers and bending gently in a downward direction away from the pins. There is a pre-formed indentation along the carrier at each pin so that the carrier will snap off without too much force. Be careful not to bend any of the terminals when removing the carriers. The integrated circuits can now be inserted in the Soldercon terminals - be sure to position the "U"-shaped indentation on the top of the IC at the proper end as indicated in the pictorials.

The resistors should be inserted next. Unless otherwise noted all resistors are inserted vertically. When installing vertically mounted components, place

the component body as shown in the pictorial. Solder the resistors as they are installed. The capacitors should be installed next. Be sure to observe polarities on electrolytics. It is good construction practice to orient components so that their labels can be read easily after the board is constructed.

Semiconductors (other than the ICs) can now be mounted; avoid overheating the germanium diodes. All diodes are mounted vertically. Make sure that transistor orientation agrees with the pictorial drawing, and observe diode polarities. Larger components, such as toroids, trim-pots, and the electrolytics on boards 4 and 5 are mounted last.

It is much easier to adjust the tuned circuits before they are mounted on the circuit boards. A good procedure is to construct all other portions of the circuit boards and then tune all ten toroids as a final step. Tuning procedures are discussed later in the manual. A few specific hints for the construction of each board are listed below.

Circuit Board No. 1 - Filter/Limiter (Figures 5, 9 and 10)

The layout shown in Figure 9 applies to the 850 Hz shift filter-limiter board; that shown in Figure 10 applies to the 170 Hz shift board. Five extra pads are provided on the circuit board for use in trimming the tuning capacitors to the correct values (C102A, C104A, C106A, C107A, C108A on board 1-850 and C152A, C154A, C156A, C157A, C158A on board 1-170).

The 22 mHy inductors required for the 170 Hz shift filter are derived by parallel-connecting the two windings of the toroids in parallel-aiding ("loose-ends" tied together and "tails," or sleeved ends, together). The 88 mHy toroids for 850 Hz shift are derived by series-aiding connection of the toroids.

The toroids are mounted to the board with the #6 hardware and large washers supplied. Assemble the hardware as follows (from top-to-bottom): screw-head, #6 flatwasher, nylon washer, toroid, circuit board, #6 lockwasher, #6-32 nut. The complete assembly should have the toroid and screw-head on the component side of the board and the nut and lockwasher on the copper side of the board.

An extra ground pad connection is provided for each toroid for greater convenience in connecting the toroids to the boards, particularly when the parallel connection is used. When the series connection is used, a spare, isolated pad (marked "CT") is provided for each toroid center tap.

Circuit Board No. 2 - Discriminator/Detector/Active Lowpass Filter
(Figures 5, 11 and 12)

The board pictorial shown in Figure 11 is used for 850 Hz shift and that shown in Figure 12 is used for 170 Hz shift. Extra pads are provided to aid in tuning the toroids.

Mount one toroid on each side of the board, assemble the parts in the following order: screw-head, #6 flatwasher, nylon washer, toroid, circuit board, nylon washer, second toroid, nylon washer, #6 flat-washer, #6-32 nut. The screw-head should be on the component side of the board and the nut on the copper side. It does not matter which toroid is used for L201 or L202. For both 170 and 850 Hz shift the toroids are connected in series-aiding. The board pictorial gives the value(s) of capacitors C206 and C256 for 60 and 100 wpm. Use the 100 wpm value if you intend to copy any speeds over 60 wpm.

Circuit Board No. 3 - Active Lowpass Filter/Slicer/Keyer (Figures 6 and 13)

Construction of circuit board No. 3 is quite straightforward. Observe the proper orientation of the 2N5655 transistor as indicated on the pictorial diagram. The electrolytic capacitors are mounted vertically (observe polarity). The pictorial shows the values of R301 and R302 required for 60 and 100 wpm. As on board No. 2, use the 100 wpm values if operation at speeds greater than 60 wpm is intended.

Circuit Board No. 4 - Autostart/Anti-space (Figures 6 and 14)

Install the IC's and resistors first, then the capacitors and remaining semi-conductors. Mount the 500 ohm, 5 watt power resistor horizontally, spacing it up off the board ¼ to 3/8" to allow for proper heat circulation. The 350 ufd and 150 ufd electrolytic capacitors are mounted horizontally; all other capacitors are mounted vertically. Note that a 3/8" wire is mounted near the upper left corner of board No. 4. This is Test Point No. 4 for use in alignment of the autostart circuit.

Circuit Board 5 - Power Supplies (Figures 7 and 15)

The normal order of component insertion should be modified for this board: put the power silicon diodes on the board first. The power diodes should be mounted vertically. Next, mount the fuse clips on the component side of the board with the 4-40 hardware supplied. The correct order of assembly is: screw head, clip, #4 lockwasher, circuit board, #4 lockwasher, #4-40 nut.

The resistors should now be mounted vertically. Be sure to observe proper placement of the resistor body. The two transistors and remaining diodes can now be mounted. Carefully observe diode polarities and transistor orientation. Next mount the ceramic capacitors and, as a final step, mount the electrolytic capacitors, observing proper polarities. The 100 ufd 250 V electrolytic is mounted horizontally - all other electrolytic capacitors are mounted vertically.

Circuit Board #6 - Meter & Lamp Driver Circuit Board (Figures 6 and 16)

This board is extremely simple. Just build it according to the pictorial. An angle bracket and 4-40 mounting hardware are furnished to mount the board. Bolt the bracket to the component side of the board before mounting the 150-ohm lamp-dropping resistors. The meter and both pilot lamps are connected directly to this board.

The lamps supplied are normally rated for 24 volts @ 40 ma. The unregulated low voltages in the ST-6 supply approximately 14 volts to the lamps, sufficient for adequate illumination, but low enough to reduce power consumption and greatly increase lifetime. Neon lamps are supplied for use as MARK and SPACE indicators.

Cabinet Wiring (Figures 8 and 17)

Included in the kit are a number of components that mount in the cabinet rather than on the boards (e.g., switches, connectors, transformers, etc.). Interconnection of the edge connectors and these components is shown in the wiring diagram and on the schematics. The functions and positions of the various switches are also indicated on the diagrams.

The shift selector switch (S8) supplied with the ST-6 kit is a 6PDT rotary switch. When the 425 Hz discriminator accessory kit is installed, S8 is replaced with a 6P3T switch furnished as part of the accessory kit. If you plan to install the 425 Hz discriminator during construction of the ST-6, consult the accessory kit manual and install the 6P3T switch rather than the switch furnished with the standard ST-6 kit.

The scope connectors furnished with the parts kit are somewhat unique, but have a number of advantages over previous connectors used for this purpose. Furnished is the 2-circuit, ¼" diameter type of phone jack most commonly used for stereo headphones. As a result, only one connection and cable are needed to supply both the vertical and the horizontal signals to the scope.

A 2500 ohm power rheostat (rather than a fixed resistor) is provided for loop current limiting. This permits adjusting loop current to the desired value regardless of how many machines are operated in the loop. Note that a 500-ohm, 5-watt resistor is wired in series with this pot to assure that the nominal value of 2750 ohms can be achieved. The rheostat should be mounted on the metal cabinet (not necessarily on the front panel) for heat-sinking, since it dissipates 9 watts in mark condition.

Loop currents less than 60 ma will require more resistance in series with the rheostat. Loop currents greater than 60 ma are not recommended because of the loop power transformer rating. The tuning meter may be switched to monitor loop current. Resistors are chosen for a full scale sensitivity of 100 ma. The autostart relay may be mounted wherever convenient, lead length should not be critical. A female 110 volt AC connector is supplied for the printer motor connection. It is usually most convenient to locate it on the rear panel of the enclosure. Other candidates for the rear panel are the CW ID Shift pot, the FSK output, the key jack, the Printer/Keyboard jack, the remote control connector, the audio input connector, and possibly the scope connector.

Three neon lamp assemblies are furnished with the parts kit. One neon is used as an AC power indicator and should be placed in series with a 68K, ½ watt resistor (R8) across the power transformer primary (180 K, 1 watt resistor for 230 volt power). The other two neon assemblies can be used to indicate MARK and SPACE conditions and should be connected with 82 K, ½ watt series resistors (R1 and R7) as shown in the schematics.

The transformer can be mounted wherever convenient. Tie strips are provided for connecting the transformer leads to the wires which run to the edge connector for board #5, and to the AC line.

A final word concerning arrangement of the boards and critical lead lengths: The board placement implied by the wiring diagram is by no means the only or necessarily the optimum arrangement. The circuitry on the boards follows a more-or-less logical progression from board #1 to board #5. However the use of two #1 boards and two #2 boards for both shifts complicate the matter somewhat.

The most critical of the lead lengths is that between the limiter on-off switch (S1) and the circuit boards. It should be reasonably short. It is a good idea to shield the audio input lead to the shift switch from the input connector. Leads to S2 (Normal-Reverse Switch) should also be reasonably short. Therefore, the position of boards #1 and #3 within the cabinet will determine the locations of S1 and S2 on the front panel. Plan the panel layout before determining the positions of the boards.

For the shortest lead lengths to S1 and S2, it is best that boards 1 and 3 be positioned with the edge connector towards the front panel. Orientation of the other boards is optional, but it is easiest to wire the edge connectors if they are all lined up (particularly for power supply connections and connections to the many switches for the autostart board #4). If the circuit cards are lined up in a row, the power supply board (#5) should be at one end to allow easy connection to the power transformer.

Figure 8, the pictorial wiring diagram, shows the board arrangement used for factory-assembled ST-6's. If you will be building your demodulator in the special HAL ST-6 cabinet, it will be easiest to simply follow this diagram.

Remember when planning the board layout to leave room for the 425 Hz discriminator board and the AK-1 AFSK oscillator board if you will be adding them now or at a later time.

The circuit boards are arranged in the HAL cabinet so that the components on boards 1-850, 1-170, 2-850, and 2-170 (as well as the AK-1, when used) face to the left of the cabinet when viewed from the front. Conversely, components of boards 3, 4, and 5 face to the right. To minimize confusion, pins of the cards facing left are numbered from 1 to 12 (~~bottom~~ to ~~top~~), and cards facing ~~left~~ are lettered from A to N (bottom to top). The layout drawings are labeled to assist in servicing and signal tracing. This is a change from nomenclature used in previous editions of this manual and applies to all wired ST-6 Demodulators with serial numbers of 168 and higher, as well as all kits provided with this manual. This modification was made to allow expansion of the ST-6 (addition of the third discriminator board to copy 425 Hz shift) and should be followed when constructing the kit to assure compatibility with future factory modifications to the ST-6. Follow the pin labeling shown on the layout sheets for cards 3, 4, and 5 and ignore the numbers printed on these cards.

5. ALIGNMENT AND TESTING

Tuning the Toroids

There are ten toroidal tuned circuits in the full ST-6 -- three in each input bandpass filter and two in each discriminator. The accuracy with which these circuits are tuned will greatly affect the overall performance of the ST-6. It is therefore important to perform the adjustments very carefully.

There are many techniques that can be used to tune the toroids. Most are described by Hoff in "Checking RTTY Shifts" (QST, May, 1966, p. 35). This article is must reading and should be included in the technical library of all amateurs interested in RTTY operation. Valuable information concerning the input filters is found in the two-part series "High-Performance RTTY Filters" in August and September, 1966, QST also by Hoff.

The procedure described below is used in alignment of all HAL-constructed ST-6's. You may wish to modify it somewhat to conform to available test equipment. As shown in Figure 4 below, the test set-up at HAL used an audio oscillator, oscilloscope, AC VTVM and a frequency counter. The 100K resistor isolates the tuned circuit from the low output impedance of the audio oscillator.

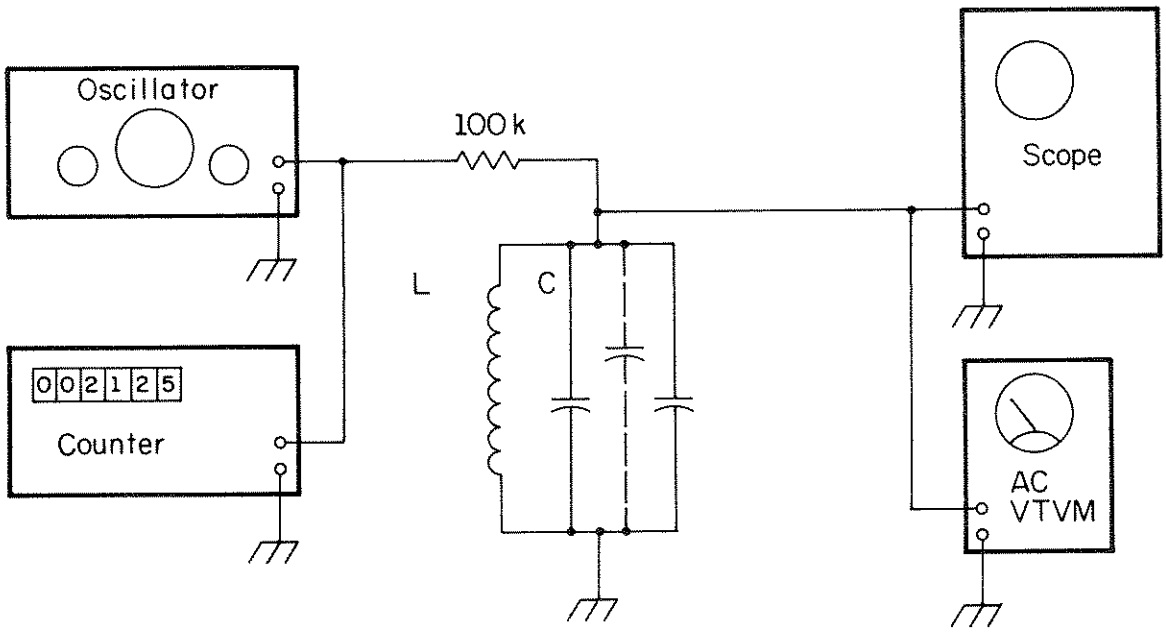


Figure 4
Toroid Alignment Techniques

As mentioned before, the adjustment procedure is much easier if performed before the toroids and tuning capacitors are installed on the boards. To adjust a tuned circuit, connect the toroid and capacitors as shown in the drawing. Set the audio oscillator to the desired resonating frequency as indicated by the counter. Adjust the oscillator amplitude until a usable reading is obtained on the VTVM and oscilloscope. Using the meter and scope as peak detectors, vary the audio oscillator frequency until the voltage across the circuit is at a maximum. Then note the counter reading.

If the frequency measured is lower than desired decrease the inductance by removing turns from the toroid; if the frequency is too high, add additional capacitance in parallel with the toroid. Each turn removed will increase the resonant frequency by approximately 3 Hz for a 2125 or 2295 Hz center frequency and 5 Hz at 2975 Hz. Conversely, each 100 pf of capacitance added will lower the resonant frequency by approximately 2 Hz at 2125 and 5 Hz at 2975 Hz. Note that these are approximate guidelines. Tune in small steps, particularly if removing turns!

The input bandpass filters are the easiest to tune and are the least critical. Note that in the layout pictorial diagram three frequencies are indicated, one for each toroid. These frequencies are the tuning frequencies associated with each inductor (f1 for L101, etc.). If the filters are tuned after all components are mounted, each inductor should be tuned separately with the others shorted. The same procedure can be used before mounting the components by remembering to add the coupling capacitors to the tuned circuit. So, in tuning L101 to 2400 Hz, use a toroid in the series 88 mHy connection paralleled by a 0.015 (C101), 0.018 (C102), and another 0.015 (C107). Similarly, L102 is tuned with C103, C104, C107, and C108 in parallel; L103 with C105, C106, and C108.

Tuning of these circuits is not overly critical and a tolerance of 20 Hz is reasonable. In general, most of the tuned circuits will be high in frequency initially requiring addition of parallel trimming capacitors. When parallel-connecting the toroids to get 22 mHy for the 170 Hz filter, be sure to parallel the windings in the proper phase (sleeved ends together, loose ends together). When adding capacitors for tuning, use mica, polystyrene, mylar, or paper capacitors (in that order of preference). DO NOT use ceramic, electrolytic, oil, or tantalum capacitors.

Tuning of the discriminators should be held to tighter tolerances (3 Hz for the 170 Hz discriminator and 5 Hz for the 850 Hz discriminator) because of the autostart circuits sensitivity to frequency error. The 2125 Hz tuned circuits are usually low in frequency initially and from 10 to 20 turns may have to be removed from the toroid to tune the circuit. When removing turns from a discriminator toroid, be sure to remove an equal number from each of the two windings to maintain the transformer balance.

The discriminator filters shift frequency slightly when all components are placed on the board as a result of interaction between the two filters. The net result is that center frequencies are shifted downward by approximately 8 Hz at 2125 Hz and 6 Hz at 2975 Hz. The procedure used at the factory to overcome this effect is to tune all discriminator toroids 10 Hz high in

frequency initially and to then trim the frequency as a final step in the alignment and test of the ST-6. This adjustment always involves addition of an extra tuning capacitor and is fairly easy to do at this late state. Alignment of the discriminators is easily checked using the tuning meter of the ST-6, since the peak readings of the meter occur at the frequencies of the discriminator toroids.

After all ten toroids and their associated capacitors have been tuned, they can be mounted on the circuit board. Be sure that the same capacitors used in the tuning of a given toroid are mounted with that toroid and not interchanged with another capacitor of the same marked value.

Alignment of the ST-6

Alignment of the ST-6 involves a limited number of preliminary checks and then adjustment of five trimming potentiometers on the circuit boards.

(1) First, trace out all wiring between edge connectors and other components to assure that no wrong connections have been made. Double check connections to the board #5 connector from the power transformer as well as all power and ground connections to other connectors.

(2) With NO circuit boards pluged in, apply power to the ST-6. If the fuse is inserted, the AC pilot lamp should glow. Use an AC voltmeter to measure the following voltages on edge connector #5:

(a) Between pins M & N - 26 VAC
(b) Between pins M & ground and pin N & ground - 13 VAC
(c) Between pins D & E - 250 VAC
(d) Between pins F & E and F & D - 125 VAC

Turn the power switch off after checking for the above voltages.

(3) Insert only circuit board #5. Be sure to get it properly oriented in the edge connector. Place the Standby/Auto switch in the Auto position (open). Turn the power on and check to see that the AC pilot lamp and the Space lamp glow. Test with a DC voltmeter for the following voltages. (Note - the following notation will be used hereafter to designate pins on edge connectors: "3(K)" refers to pin No. K of the edge connector for circuit board No. 3. Similarly, "1-170 (10)" refers to pin 10 of the edge connector for circuit board No. 1, 170 Hz shift).

(a) 5(J) to ground - +12 volts
(b) 5(H) to ground - -12 volts
(c) 5(C) to ground - +200 volts
(d) Short the printer jack (either side) to ground and measure: 5(F) to ground - -175 volts
(e) Measure +12 volts to ground at the following locations: 1-850(2), 1-170(2), 2-850(11), 2-170(11), 3(K), 4(M), either coil terminal of the relay, and the +12 V connection to the meter-lamp-driver board.

(f) Similarly, measure -12 volts to ground at the following locations: 1-850(11), 1-170(11), 2-850(10), 2-170(10), 3(L), 4(K).

(g) Make sure that the following pins are grounded: 1-850(1), 1-170(1), 2-850(1), 2-170(1), 3(A), 4(A), 5(A).

Turn off the power switch after completing the above voltage checks.

(4) Now plug in all of the remaining circuit cards and turn the power on again. If a fuse blows or smoke appears, immediately shut off the power and locate the problem.

(5) The input limiter stages can now be tested and aligned. Ground the audio input of the TU and connect a DC voltmeter to pin 8 of circuit board 1-170 (a zero-center meter with a -10 to +10 V scale is best). Adjust the trimming potentiometer on the board for 0 volts output. Not all of the SN72709N operational amplifiers will adjust to zero in this location. This does NOT indicate a defective operational amplifier. The range of adjustment of the trim-pot is intentionally restricted so that only the 709's with the lowest offset can be used in the input limiter stage. If the initial 709 will not adjust to zero, try "swapping" it with other of the 709's. Offset is not a critical parameter for any of the amplifiers except OA-101, OA-151. The limiter switch should be in the "ON" position for these adjustments.

(6) Adjust the 1-850 board in the same manner.

(7) The discriminators can now be aligned and tested.

(a) Set the meter switch to the tune position. Connect the signal generator to the audio input jack of the ST-6 and adjust the frequency until a peak is indicated on the tuning meter. Measure the frequencies of the two peaks of each discriminator and trim the tuning of each until the proper frequencies are measured -- remember to set the SHIFT switch to the correct position for the discriminator being tested.

(b) Tune to the center frequency of the Mark filter (2125 Hz) in the 850 Hz discriminator. Adjust the tuning meter potentiometer on the meter/lamp-driver board for a meter reading of 0.7.

(c) Tune the oscillator to the center of the space filter (2975 Hz) as indicated by a peak on the tuning meter. Adjust the trim-pot on the 850 Hz discriminator board (2-850) so that the tuning meter again reads 0.7.

(d) The 170 Hz filters will not indicate as high on the tuning meter as the 850 Hz units, but the technique is basically the same as outlined above - note the meter reading when peaked at 2125 Hz, peak at 2295 Hz and adjust trim-pot (2-170 board) for the same reading.

(8) Next, the autostart sensitivity potentiometer on circuit board #4 is adjusted. Connect a DC voltmeter (again, preferably a zero-center meter) to test point 4 on circuit board #4. With the Normal - Reverse switch set for "Normal" and the autostart switches in the "Auto" position, apply a 2125 Hz signal to the ST-6 (the TU can be set for either shift - it is best to adjust for whichever shift you use the most). Now, detune the oscillator in either direction until the tuning meter indicates 80% of its peaked value (0.56 for 850 shift). Adjust the trim-pot on board #4 until the voltage at test point 4 flickers back and forth between plus and minus voltages. Note that if the autostart response switch, S4, is set for "Fast" mode, the Receive - Standby pilot lamps will also flicker back and forth if the adjustment is made with sufficient care. Choosing the setting of the autostart threshold is a matter of personal preference. Setting it too close to the peak frequency will mean turn-on's only for precise shifts; setting it too far away may result in turn-on's for noise, CW signals, etc. You may wish to change this adjustment after you have had some experience in operating the ST-6.

This completes the alignment of the ST-6 RTTY Terminal Unit.

Testing the ST-6

After tuning and alignment is completed test the operation of the individual features of the ST-6.

(1) Check the operation of the input bandpass filters by connecting the oscillator to the AF input of the ST-6 and the oscilloscope to pin 8 of the proper board 1 for the shift being tested. With the limiter switch in the "OFF(AM)" position and the signal generator at 2125 Hz, adjust the oscillator amplitude until the scope display is a sine-wave. The response of the filter can now be observed by changing the oscillator frequency. Do not expect a perfectly flat response from either filter but do make sure that the output drops off above and below the 2125/2295 range or 2125/2975 range.

(2) The limiter stage can be checked by repeating the above step with the limiter switch in the "ON(FM)" position. The scope display should be a square wave of constant amplitude with respect to frequency. Limiting will start with as little as a few millivolts audio input.

(3) Operation of the discriminator stages and other stages has already been checked.

(4) The anti-space circuit can be checked in the following manner: With the autostart switches in the "OFF" positions and the Normal-Reverse switch set to "Normal," connect the oscillator to the AF input and set it to 2125 Hz. The Mark pilot lamp should now be glowing. Flip the Normal-Reverse switch to "Reverse". The Space pilot lamp should come on for about a second and then go back to Mark. Without the anti-space feature, the TU would stay in Space condition continuously. The anti-space always works, whether or not the autostart mode is selected.

(5) Next, check the autostart response. Connect the oscillator, set to 2125 Hz, to the AF input and set the switches to the following positions: "Normal," "Limiter-On," "Fast" response, "Autostart On" (S5), "Auto" (S3), "Auto" (S6, motor). The Mark pilot lamp and the Receive lamp should now be glowing. Disconnect the oscillator and the Standby lamp will come on in a few seconds, indicating that the autostart circuit has dropped out. The Receive lamp should again light approximately 1 or 2 seconds after reconnecting the oscillator to the input. With the response switch in the "Slow" position, a longer time will be required to activate or deactivate the autostart system -- typically, the time required for 5 or 6 RTTY characters.

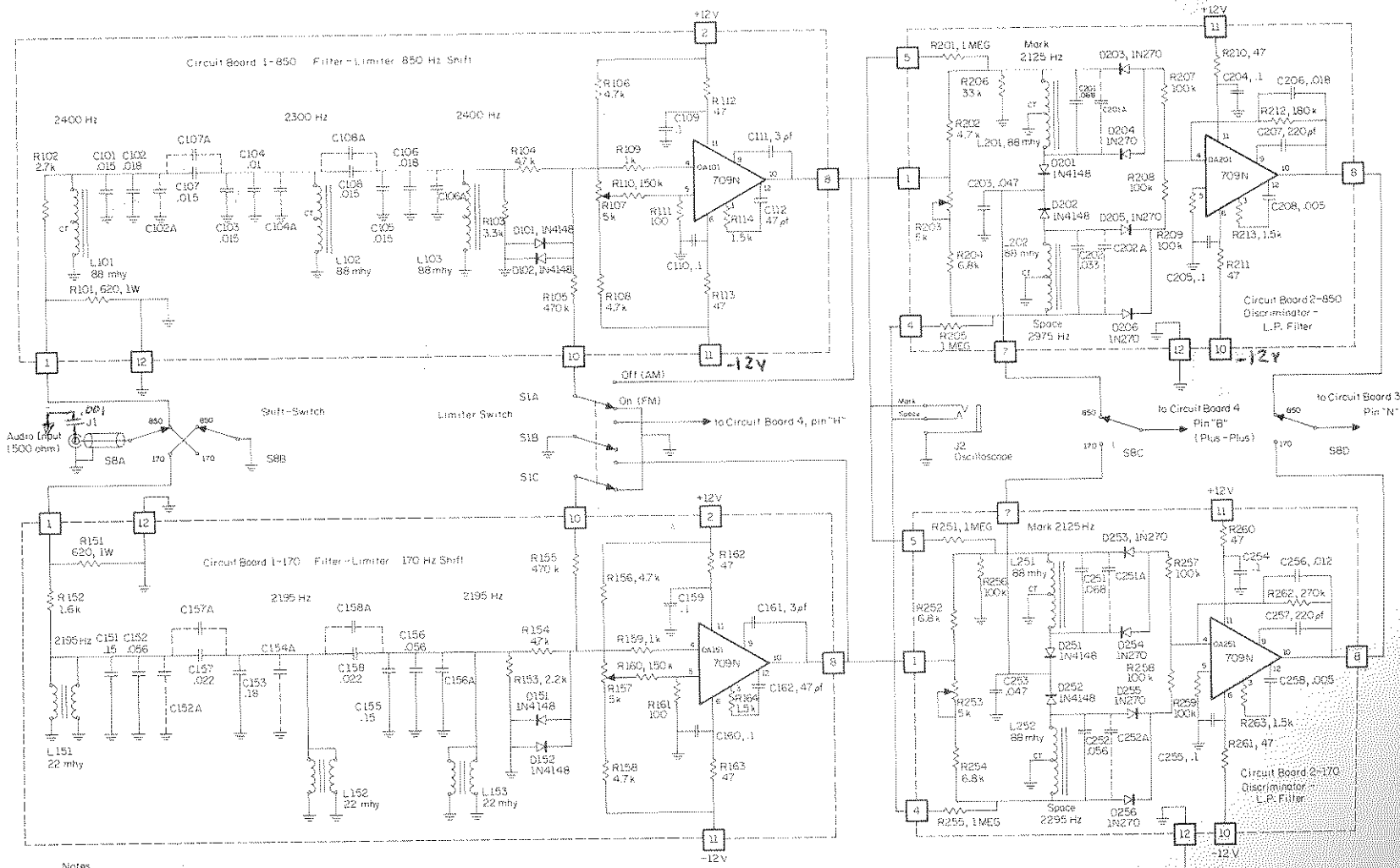
(6) With the slow-fast switch in the "slow" position, and the other switches as above, check the motor control by disconnecting the oscillator from the TU. Between 25 and 50 seconds after loss of signal (the exact time depends upon electrolytic capacitance tolerance), the autostart relay will open, removing power from the printer and placing the TU in standby open-loop status. (Note: The motor control will not operate in the Fast mode. All of the autostart is defeated in the AM mode.) The hold-on time of the motor control can be changed, if desired, by changing the value of C416 and/or R431 on card 4.

(7) Note that with the Standby switch in "Standby," the printer is held in mark condition and there is no way that an incoming signal can be printed, automatically or manually, until this switch is thrown to the Auto position. Therefore, both the Receive and Standby lamps are lit whenever the TU is in Standby mode to serve as a reminder not to leave the TU in this mode.

(8) The final test is to copy signals with the ST-6 hooked up to a receiver and printer.

6. SCHEMATIC AND CABINET WIRING DIAGRAMS

The schematic and cabinet wiring diagrams are shown on the following pages.



Notes

1. All resistors 1/4 W unless otherwise noted.
2. Capacitors designated with a letter suffix (e.g., C102A, C151A, etc.) are additional circuit board locations to assist in tuning filters.
3. Capacitor C154 is not used.
4. Low Pass Filter parameters are shown for 100 WPM equalization; for 60 WPM only, change C206 to 0.033 μfd & C256 to 0.02 μfd. (See Manual)
5. Frequencies indicated for input filter sections are tuning frequencies when other sections are shorted. (See Manual)
6. See "Three-Shift Modification" diagram for changes to include three discriminators.
7. Component Numbering System:
   - X001 - X099, Main Frame
   - X101 - X149, Circuit Board 1-850
   - X151 - X199, Circuit Board 1-170
   - X201 - X249, Circuit Board 2-850
   - X251 - X299, Circuit Board 2-170

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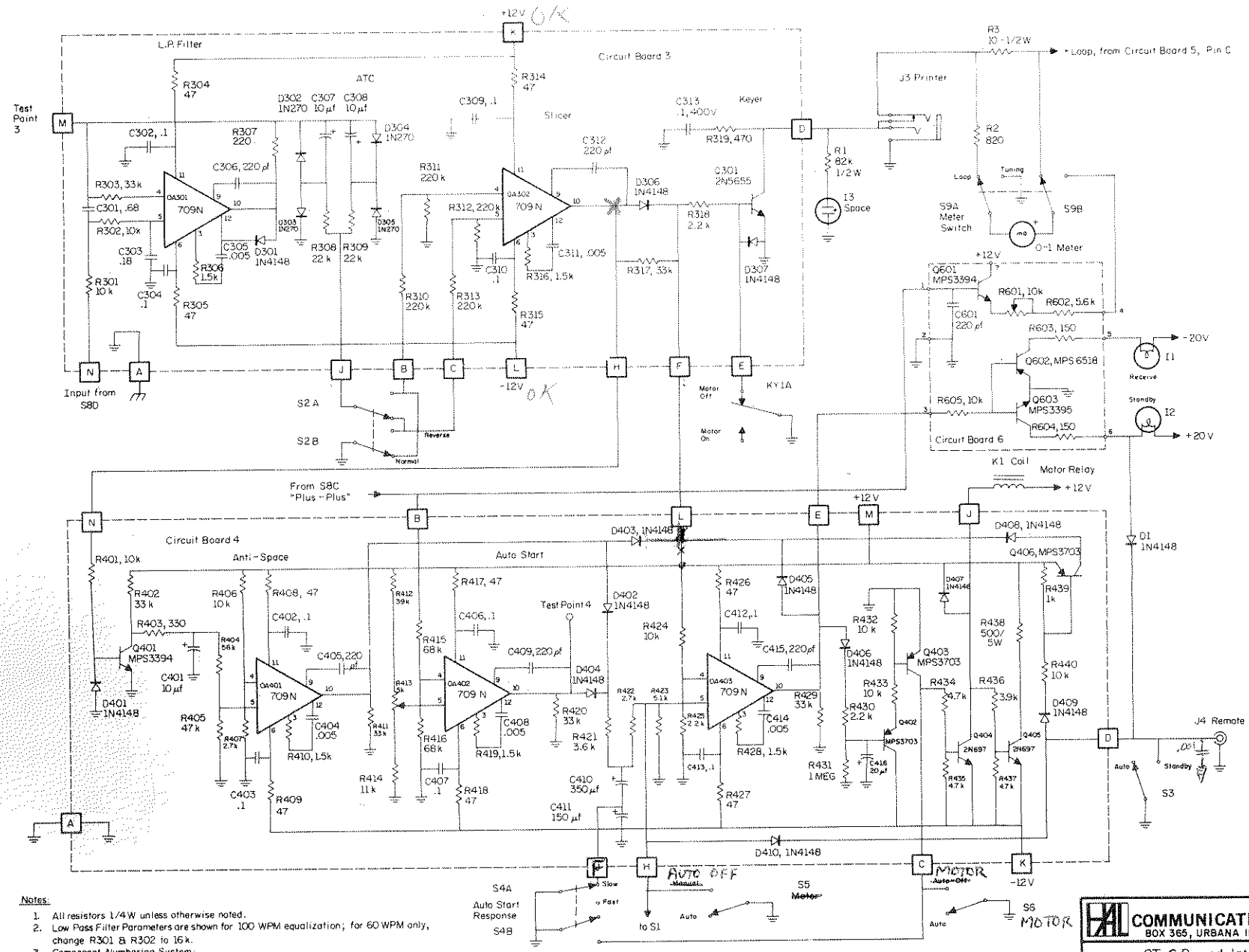
ST-6 Demodulator
Circuit Boards 1 and 2

DATE	July 24, 1972	SCALE	
APPROVED		No.	ST-6, S1



Notes:

1. All resistors 1/4W unless otherwise noted.
2. Low Pass Filter Parameters are shown for 100 WPM equalization; for 60 WPM only, change R301 & R302 to 16k.
3. Component Numbering System:
   - X001-X099, Main Frame
   - X301-X399, Circuit Board 3
   - X401-X499, Circuit Board 4
   - X601-X699, Circuit Board 6

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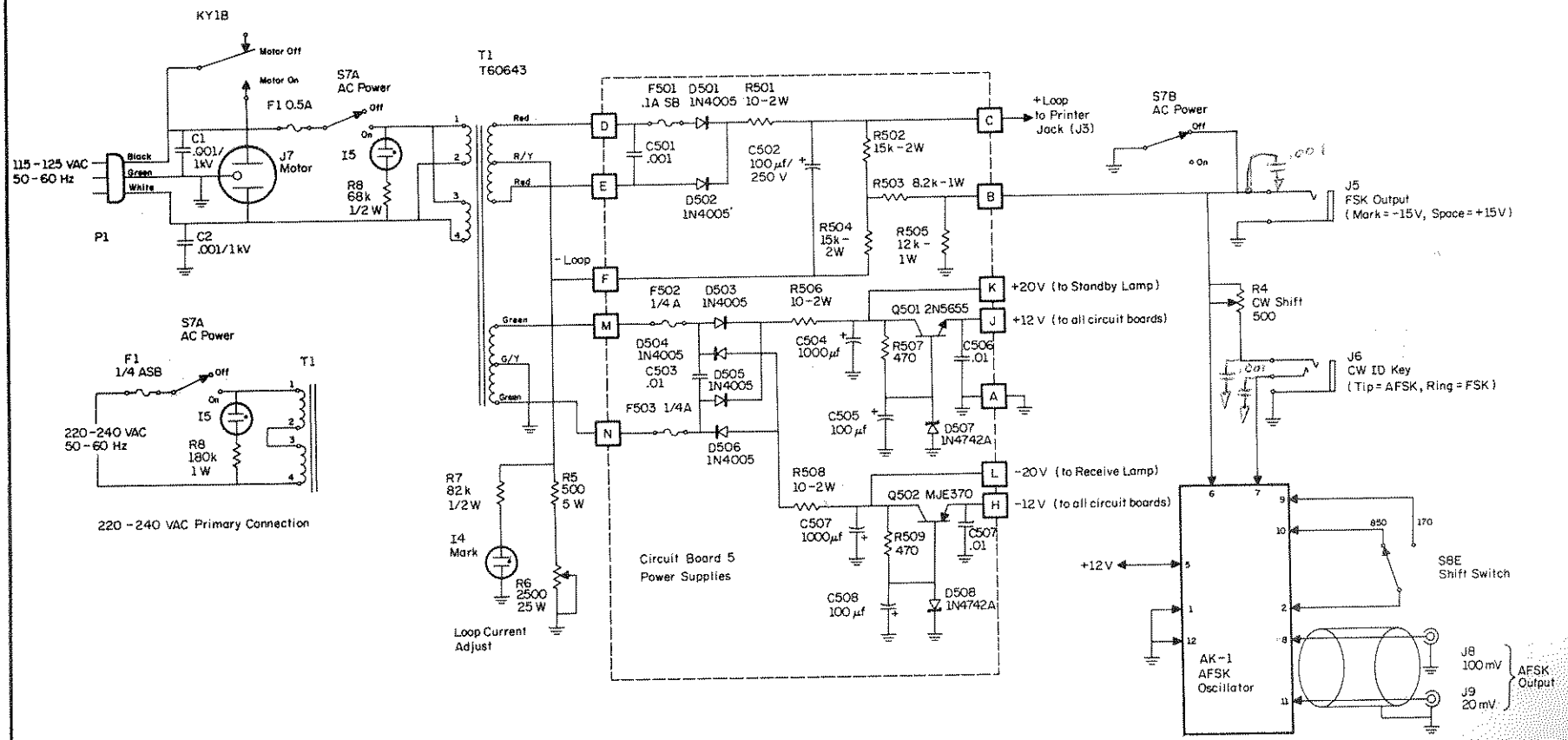
ST-6 Demodulator
Circuit Boards 3, 4, and 6

DATE	July 15, 1972	SCALE	—
APPROVED	G.W.H.		ST-6, S2



Notes:

1. All resistors 1/4 W unless otherwise noted.
2. Resistor R6 dissipates 9 Watts under Mark conditions and should be heat-sinked by mounting on metallic panel.
3. I-3, I-4, & I-5 are NE-2 type neon lamps.
4. Component Numbering System:
   X001 - X099, Main Frame
   X501 - X599, Circuit Board 5

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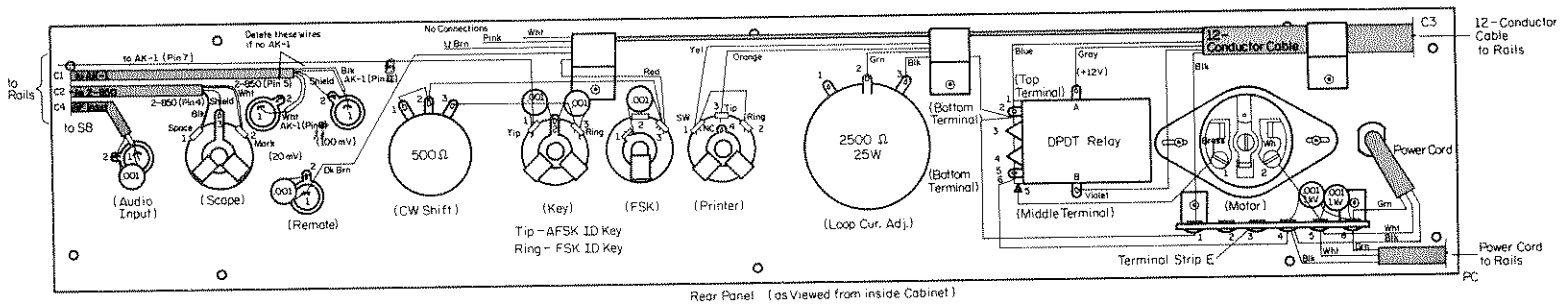
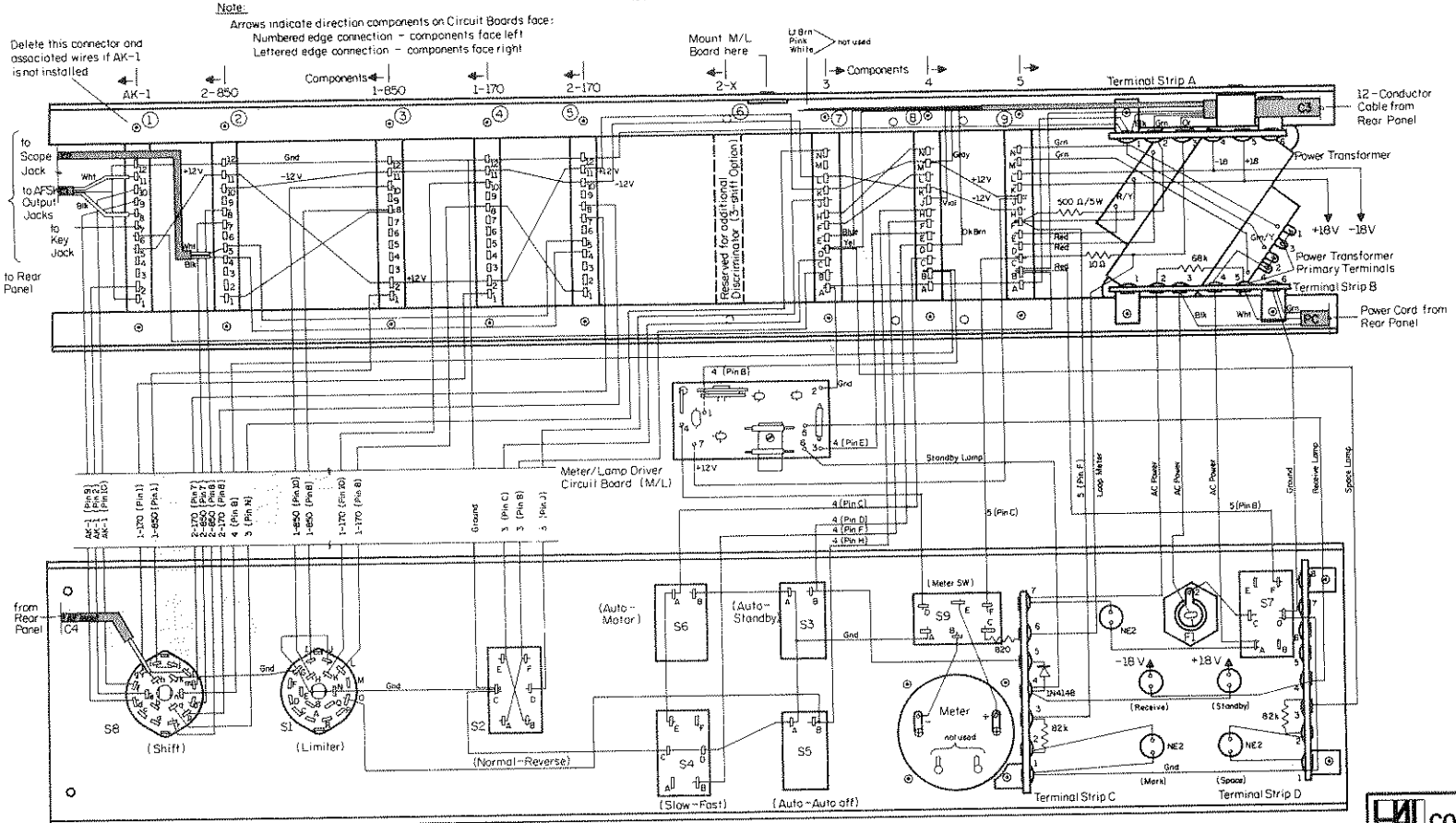
ST-6 Demodulator
Circuit Board 5

DATE	July 8, 1972	SCALE	—
APPROVED		No.	ST-6, S3



Rear Panel (as Viewed from inside Cabinet)

Note:
Arrows indicate direction components on Circuit Boards face:
Numbered edge connection – components face left
Lettered edge connection – components face right



Front Panel (as Viewed from Inside)

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ST-6 Wiring Diagram

DATE August 8, 1972	SCALE
APPROVED G. W. H.	ST-6, W1

7. CABINET AND CIRCUIT BOARD PHOTOGRAPHS

The photographs on the following pages show the position of the components on the circuit boards, and the internal cabinet wiring.

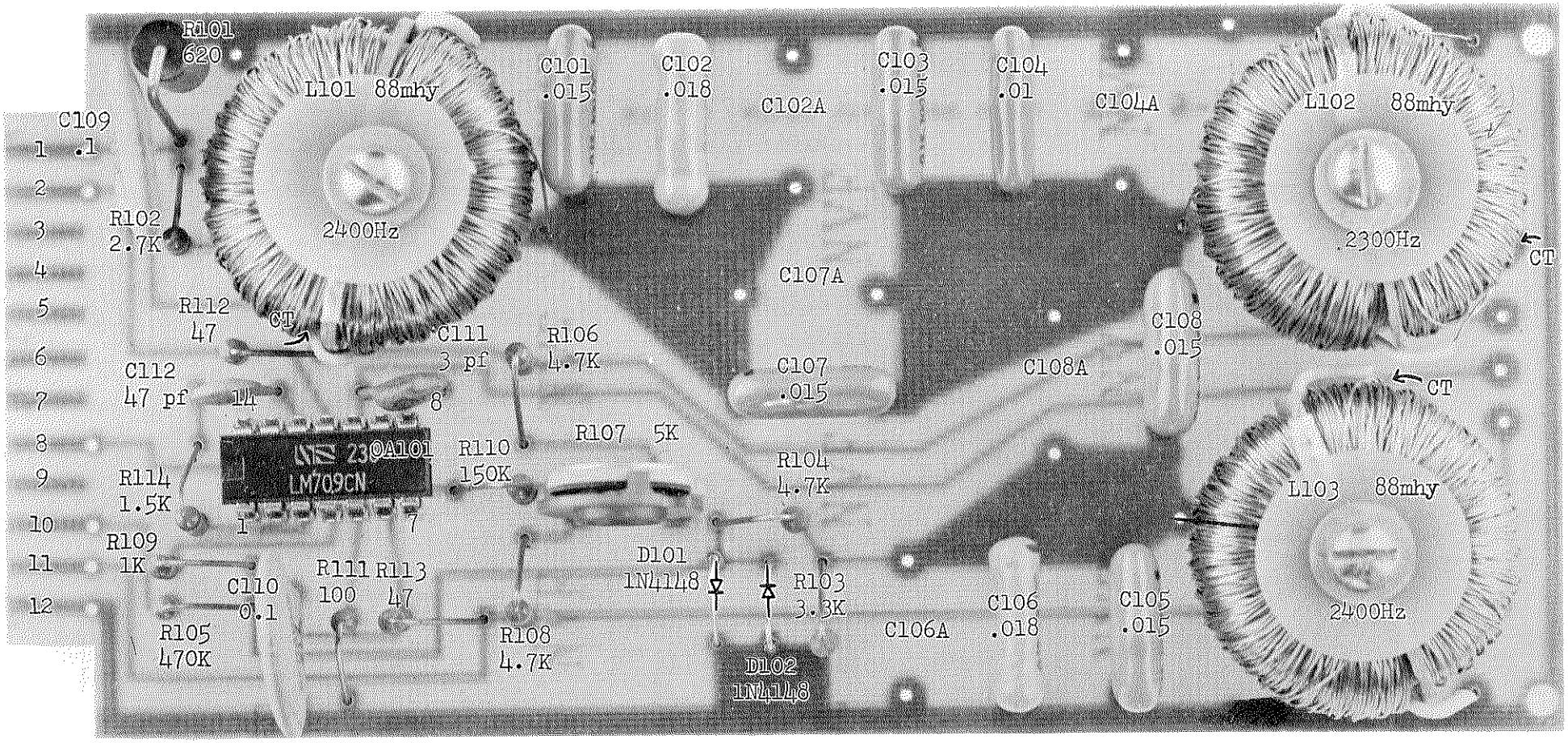


Figure 9
Circuit Board No. 1 - 850 Pictorial

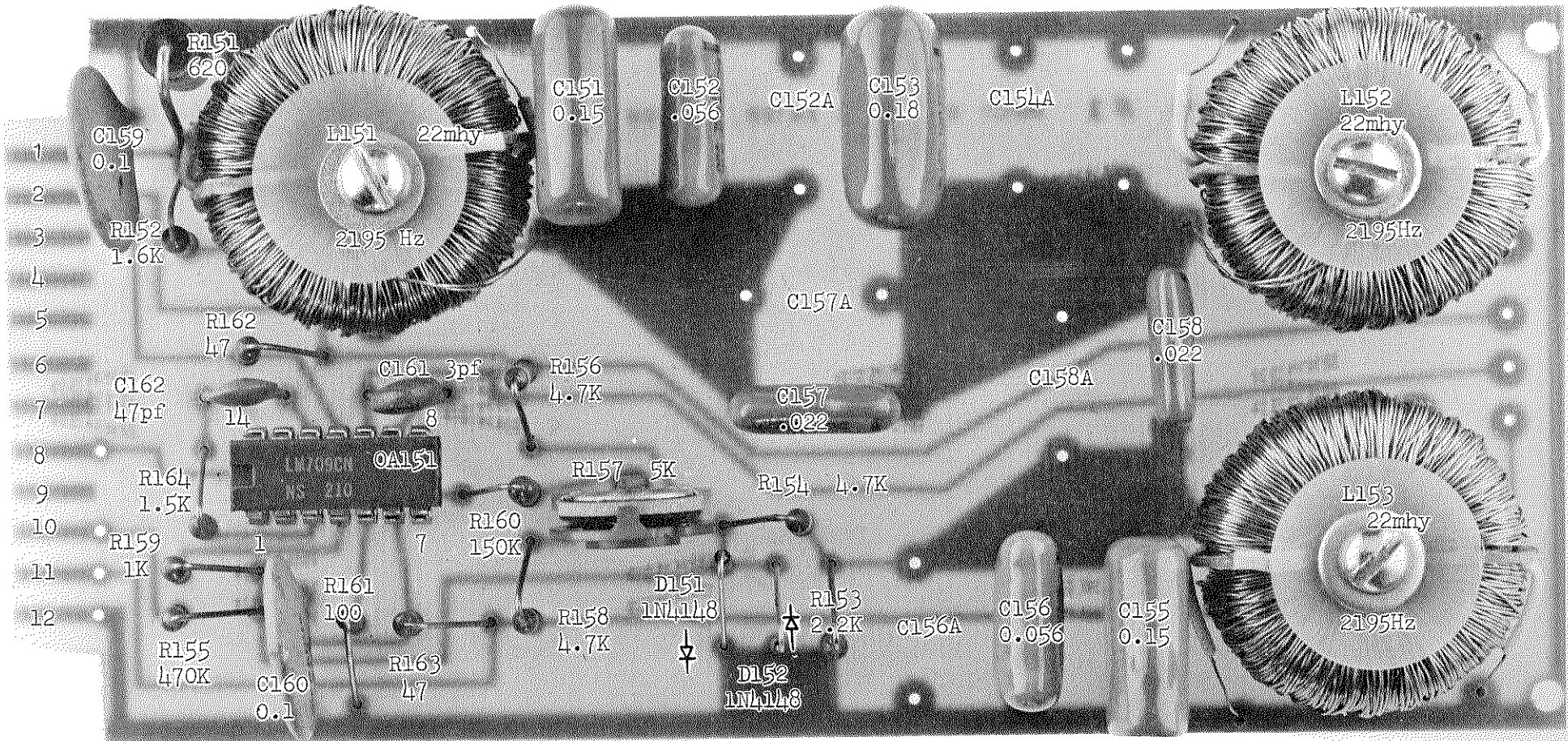


Figure 10
Circuit Board No. 1 - 170 Pictorial

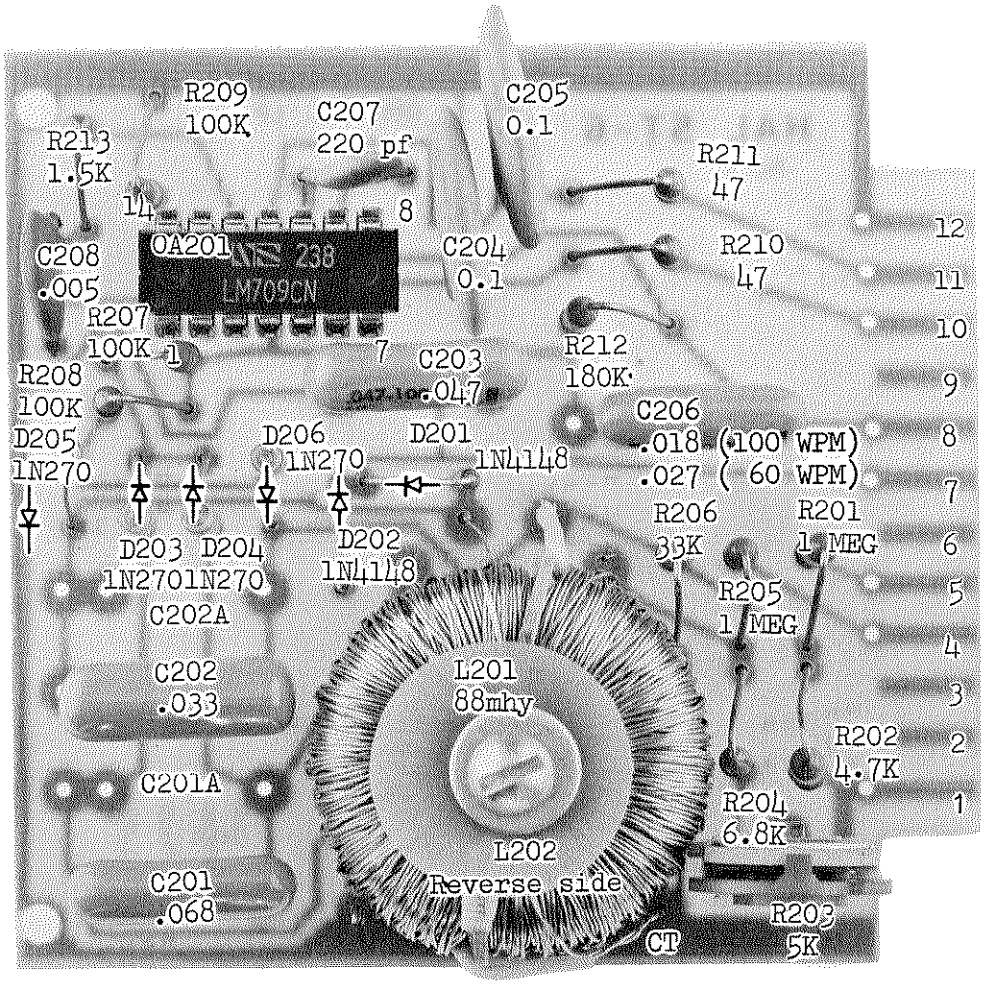


Figure 11
Circuit Board No. 2 - 850 Pictorial

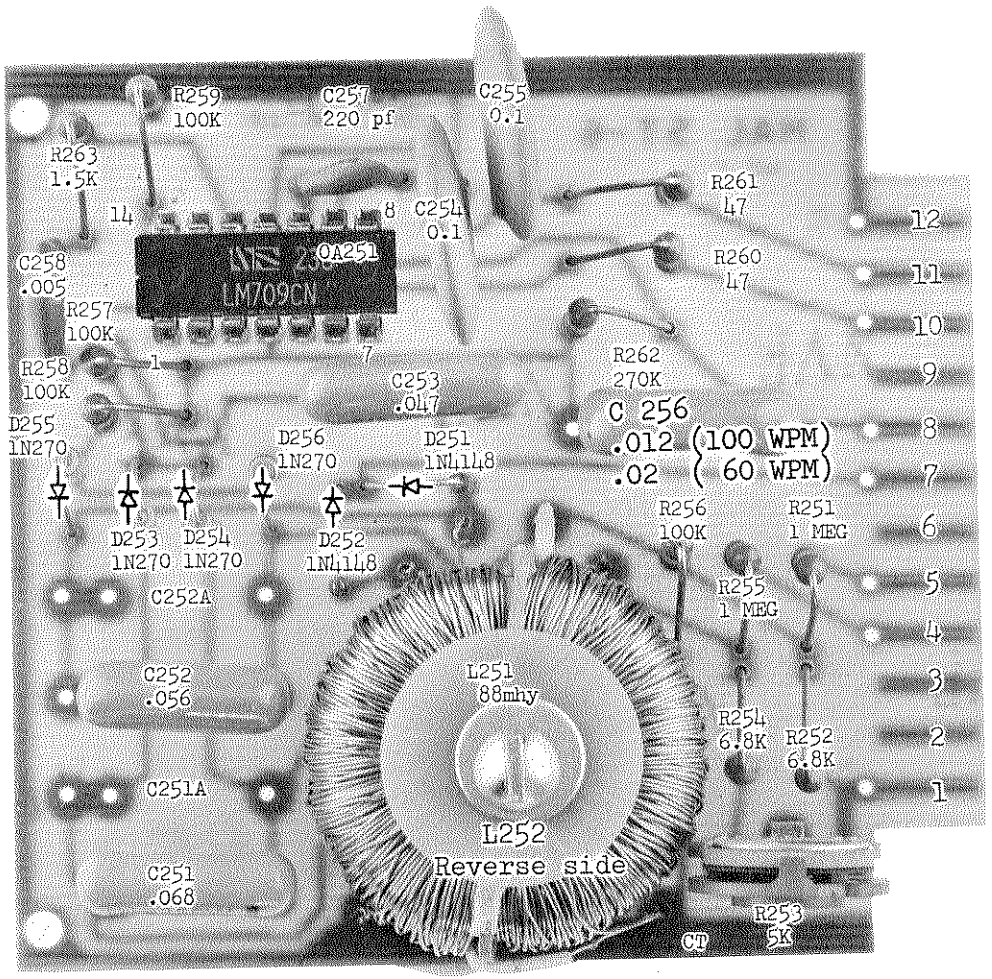


Figure 12
Circuit Board No. 2 - 170 Pictorial

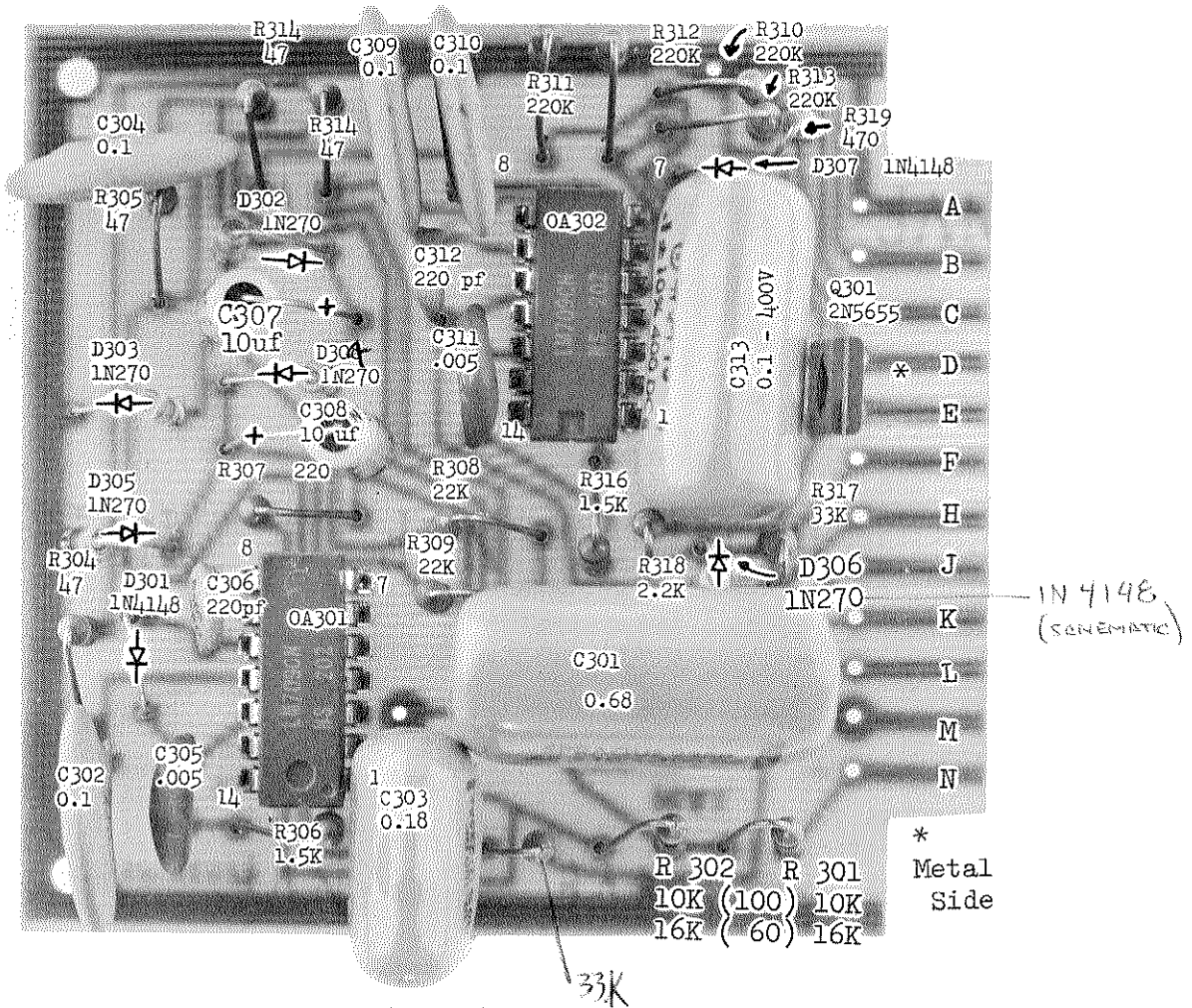


Figure 13
Circuit Board No. 3 Pictorial

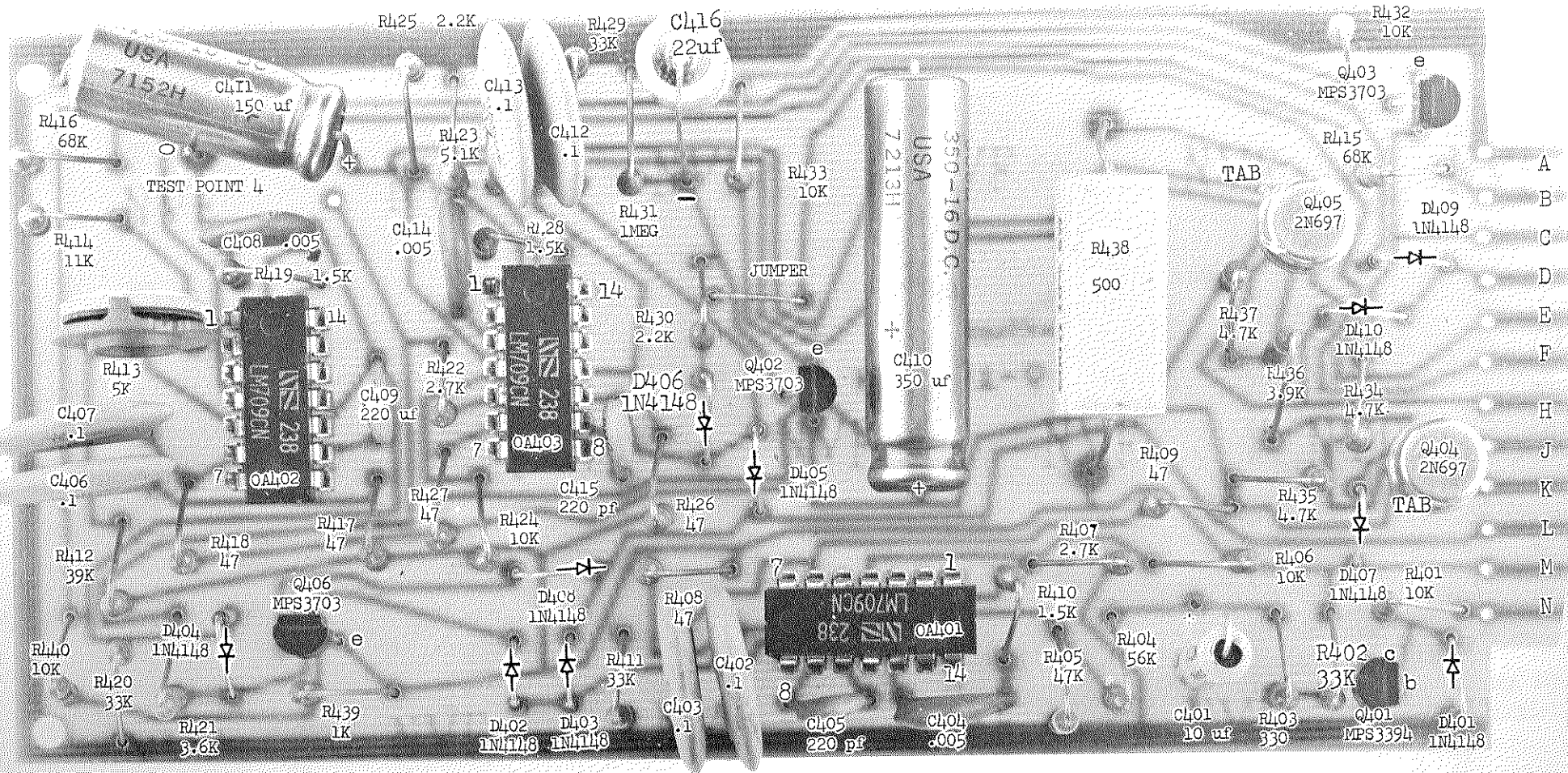


Figure 14
Circuit Board No. 4 Pictorial

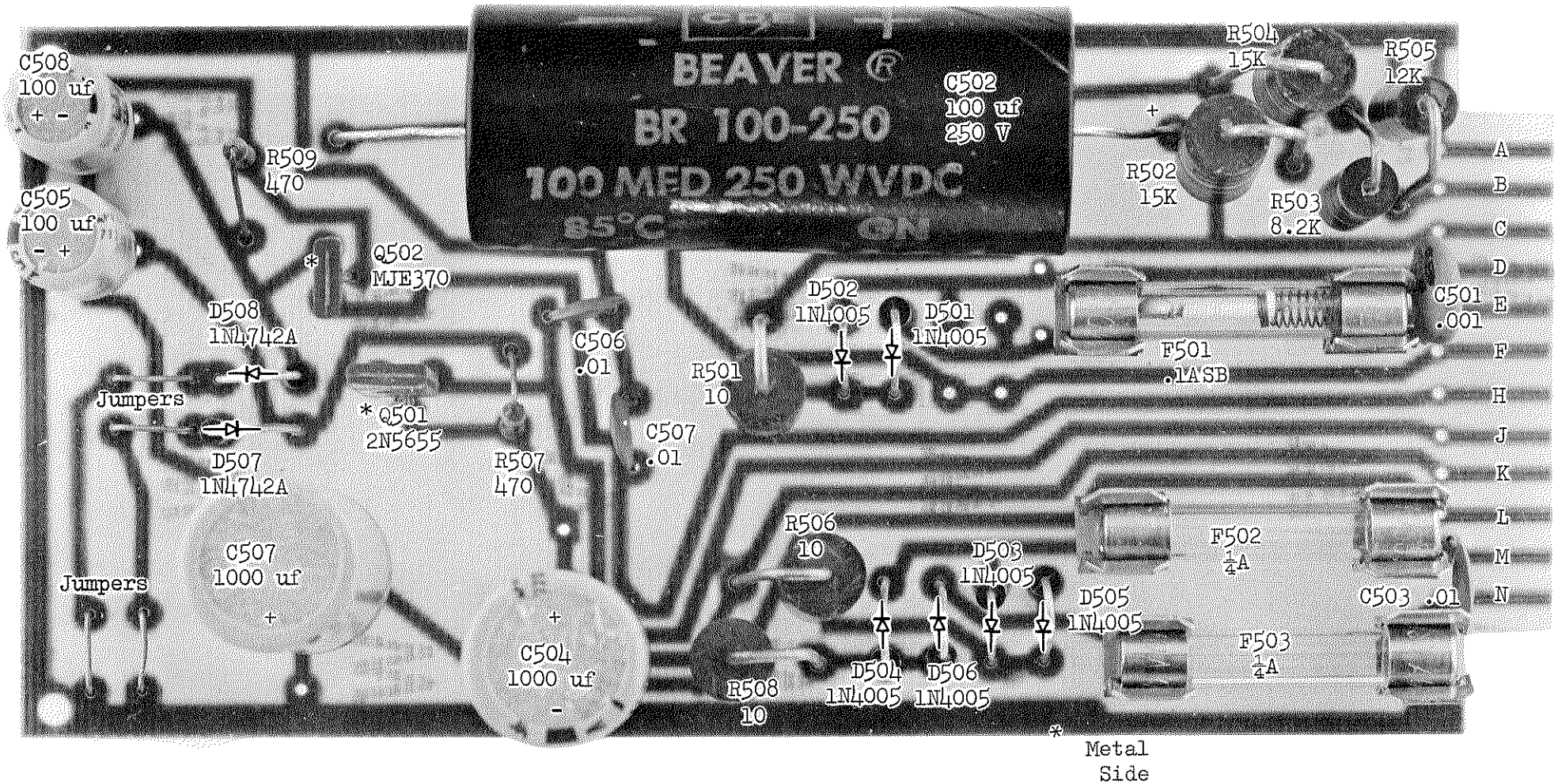


Figure 15
Circuit Board No. 5 Pictorial

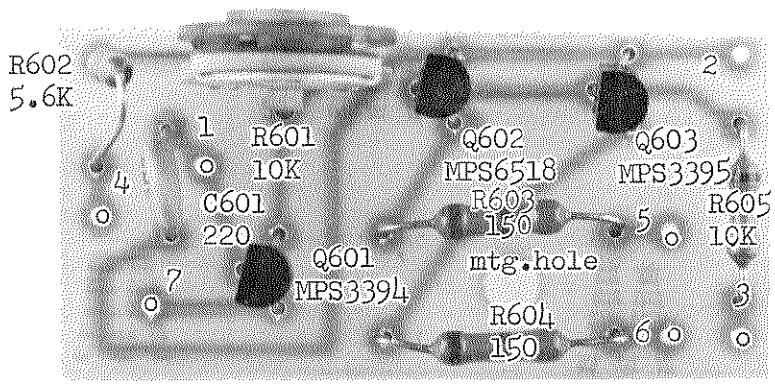


Figure 16
Circuit Board No. 6 Pictorial

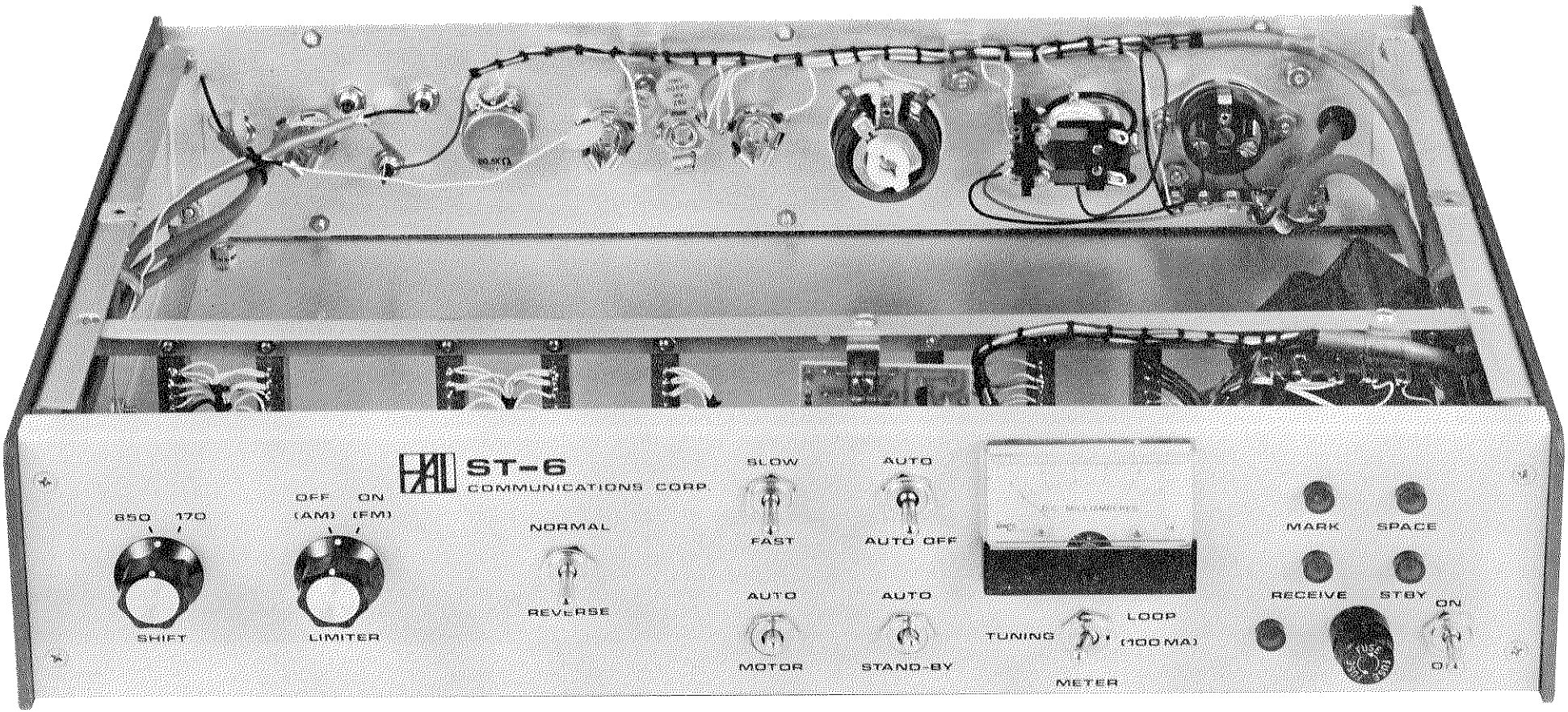


Figure 17
Cabinet Pictorial

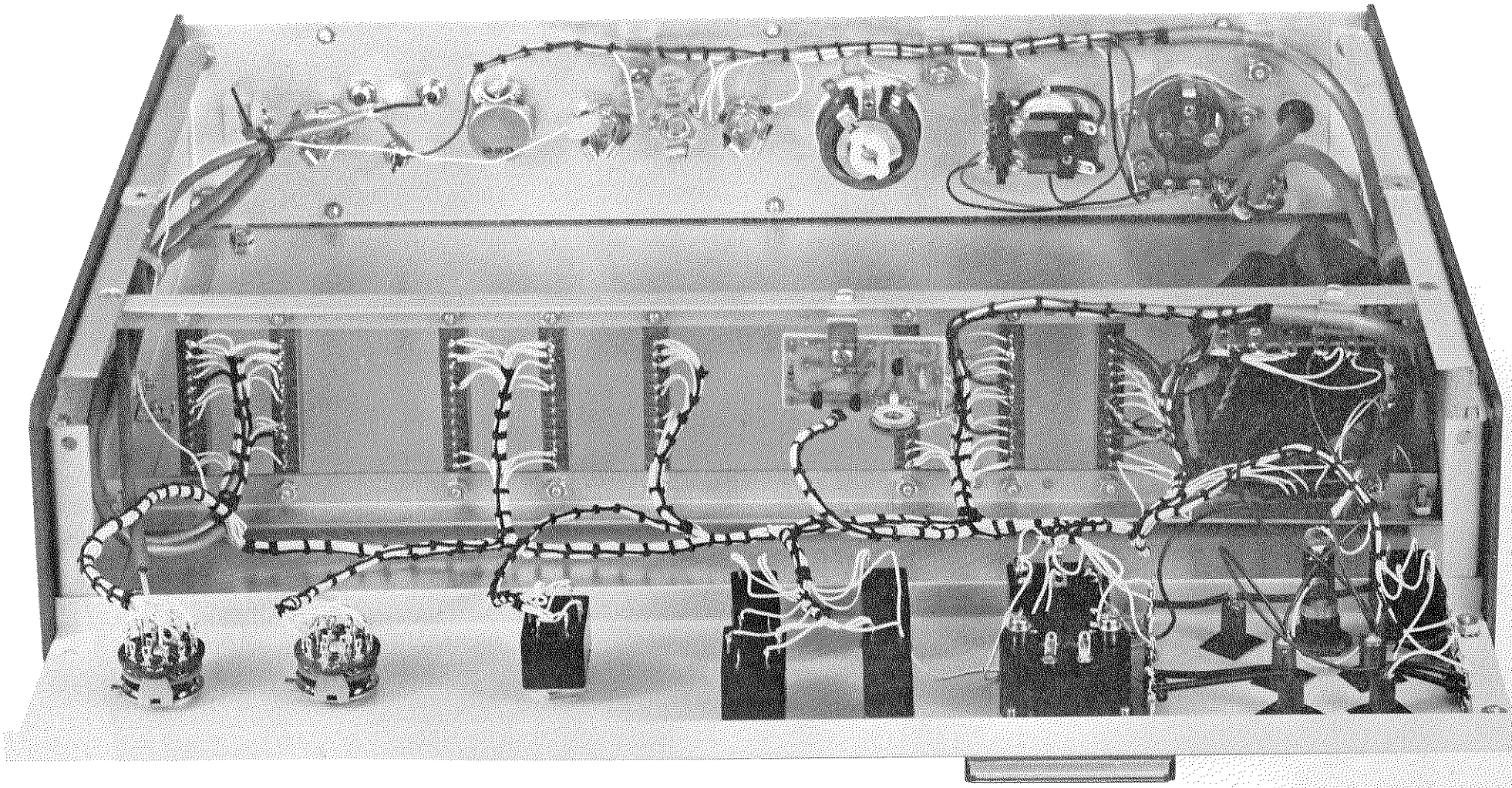


Figure 18
Cabinet Pictorial

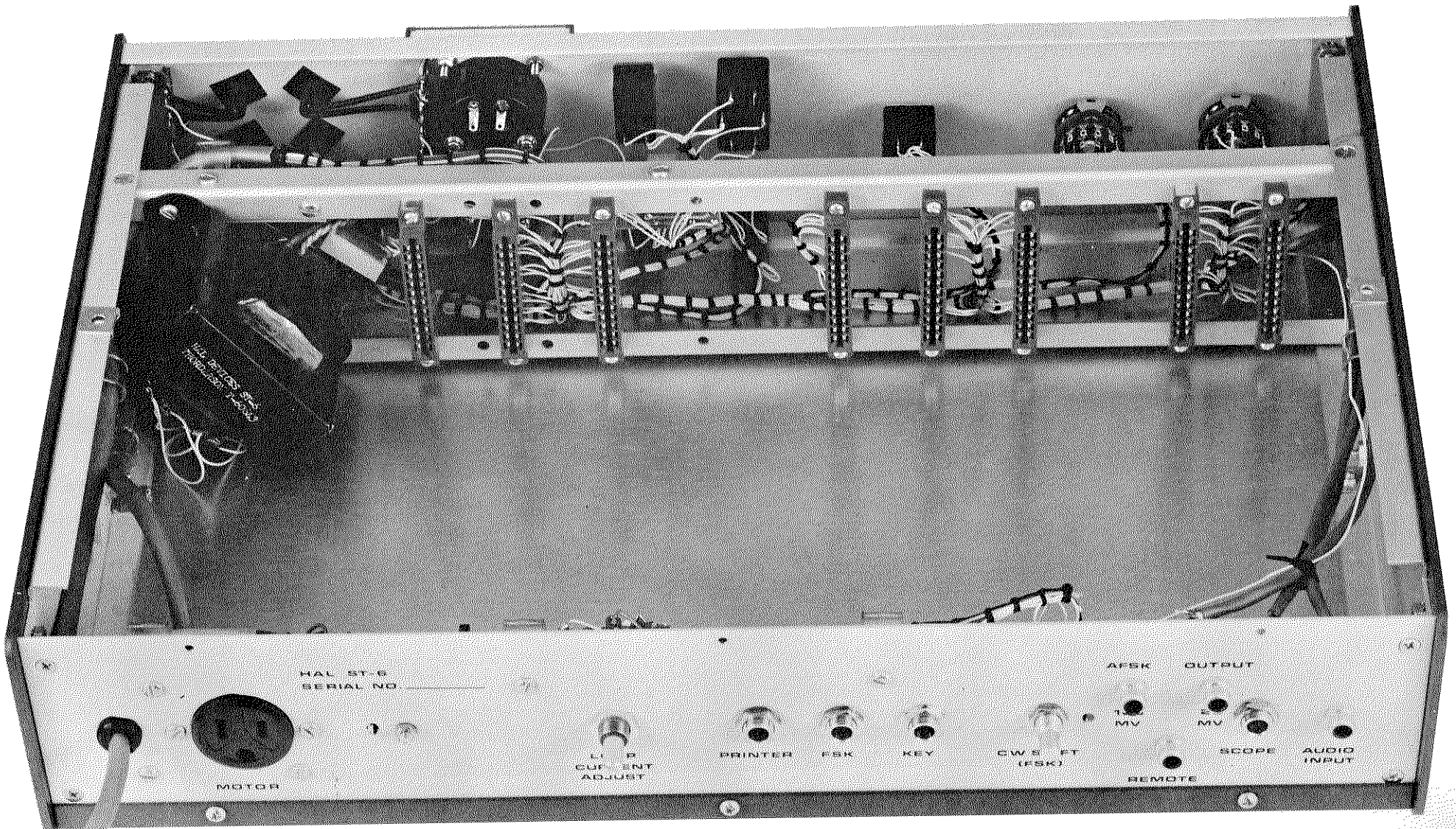


Figure 19
Cabinet Pictorial

8. PARTS LIST

Component	Total Used	(Quantities used on circuit boards) 1 170	1 850	2 170	2 850	3	4	5	6	Cabinet
Resistors, ¼watt, 10%:										
10 ohm (½watt)	1									1 (Loop Current Mtr.)
47 ohm	18	2	2	2	2	4	6			
100 ohm	2	1	1							
150 ohm	2								2	
220 ohm	1					1				
330 ohm	1						1			
470 ohm	3					1		2		
820 ohm	1									1 (Loop Current Mtr.)
1000 ohm	3	1	1				1			
1500 ohm	9	1	1	1	1	2	3			
2200 ohm	4	1				1	2			
2700 ohm	3		1				2			
3300 ohm	1		1							
3900 ohm	1						1			
4700 ohm	10	3	3		1		3			
5600 ohm	1								1	
6800 ohm	3			2	1					
10 K	9					2 (100wpm)	6		1	
22 K	2					2				
33 K	7				1	2	4			
39 K	1						1			
47 K	1						1			
56 K	1						1			
68 K (1-½w,2-¼w)	3						2(¼w)			1 (Neon dropping) (½w)
82 K (½watt)	2									2 (Neon dropping)
100 K	7			4	3					
150 K	2	1	1							
180 K	1				1					
220 K	4					4				
270 K	1			1						
470 K	2	1	1							
1 megohm	5			2	2		1			
Resistors, 5%:										
620 ohm (1 watt)	2	1	1							
1600 ohm	1	1								
3600 ohm	1						1			
5100 ohm	1						1			
11 K	1						1			
16 K	2					2(60wpm)				
Resistors, 10%, 1 and 2 Watt:										
10 ohm (2 watt)	3							3		
8200 ohm (1 watt)	1							1		
12 K (1 watt)	1							1		
15 K (2 watt)	2							2		

Component	Total Used	(Quantities used on circuit boards) 1 170	1 850	2 170	2 850	3	4	5	6	Cabinet
Power Resistors:										
500 ohm (5 watt)	2						1			1
2500 ohm (25 watt) (rheostat)	1									1
Potentiometers:										
500 ohm (Panel Mtg.)	1									1
5 K (PC Mtg-trim)	5	1	1	1	1		1			
10 K (" " ")	1								1	
Capacitors, Disc Ceramic:										
3 pf	2	1	1							
47 pf	2	1	1							
220 pf	8			1	1	2	3		1	
0.001 mfd (1 kV)	38							1		7 (Line By-pass)
0.005 mfd	7			1	1	2	3			
0.01 mfd	3							3		
0.1 mfd	18	2	2	2	2	4	6			
Capacitors, Mylar:										
0.01 mfd	1		1							
0.012 mfd	1			1(100wpm)						
0.015 mfd	5		5							
0.018 mfd	3		2		1(100wpm)					
0.02 mfd (200 V)	1			1(60wpm)						
0.022 mfd	2	2								
0.027 mfd	1				1(60wpm)					
0.033 mfd	1				1					
0.047 mfd	2			1	1					
0.056 mfd	3	2		1						
0.068 mfd	2			1	1					
0.10 mfd (400 V)	1					1				
0.15 mfd	2	2								
0.18 mfd	2	1				1				
0.68 mfd	1					1				
Capacitors, Electrolytic:										
10 mfd / 15 V	3					2	1			
20 mfd / 15 V	1						1			
100 mfd / 25 V	2							2		
100 mfd / 250 V	1							1		
150 mfd / 16 V	1						1			
350 mfd / 16 V	1						1			
1000 mfd / 25 V	2							2		
Semiconductors, Diodes:										
1N270 Germanium	12			4	4	4				
1N4148 Silicon(S)	22	2	2	2	2	3	10			1 (Remote Switch)
1N4742 Zener	2							2		
1N4005 (600 PIV Silicon)	6							6		

Component	Total Used	(Quantities used on circuit boards) 1 170	1 850	2 170	2 850	3	4	5	6	Cabinet
Semiconductors, Integrated Circuits:										
709N	9	1	1	1	1	2	3			
Semiconductors, Transistors:										
2N697	2						2			
2N5655	2					1		1		
MJE370	1							1		
MPS3394	2						1		1	
MPS3395	1								1	
MPS3703	3						3			
MPS6518	1								1	
Connectors:										
12 Pin Edge Conn.	7	1	1	1	1	1	1	1		2
Phono Jack	2									2 (Mate above)
Phono Plug	2									3
2 Circuit Jacks(¼")	3									3 (Mate above)
2 Circuit Plugs(¼")	3									1
1 Circuit Jack(¼")	1									1 (Mate above)
1 Circuit Plug(¼")	1									1
117 VAC Female Socket	1									
14 Pin IC Sockets	9	1	1	1	1	2	3			
Switches:										
DPDT Toggle	4									4
SPST Toggle	3									3
6PDT Rotary	2									2
DPDT, 24 VDC Relay	1									1
Coils, Transformers:										
88 mhy Toroids	10	3	3	2	2					
T-60643 Power Trans.	1									1
Circuit Boards:										
Circuit Board #1	2	1	1							
Circuit Board #2	2			1	1					
Circuit Board #3	1					1				
Circuit Board #4	1						1			
Circuit Board #5	1							1		
Circuit Board #6	1								1	
Miscellaneous Components:										
0.100 Amp Fuse S.B.	1							1		
0.250 Amp Fuse	2							2		
0.500 Amp Fuse	1									1
Fuse Holder	1									1
Fuse Clips	6							6		

Component	Total Used	(Quantities used on circuit boards) 1 170	1 850	2 170	2 850	3	4	5	6	Cabinet	
Miscellaneous Components:											
Power Cord	1									1	
Lamp bezels	5									5	
Lamp bezel clips	5									5	
Neon lamps	3									3	
Incandescent lamps	2									2	
Meter, 0-1 ma	1									1	
Strain relief	1									1	
6 terminal tie-strips	3									3	
8 terminal tie-strips	2									2	
Cable clamps	7									7	
Construction manual	1										
Hardware:											
4-40 x ¼" screws	7							6	1		
4-40 nuts	21							6	1	14	
#4 Lockwashers	27							12	1	14	
6-32 x 1" screws	6	3	3								
6-32 x 1 3/4" screws	2			1	1						
6-32 nuts	23	3	3	1	1					15	
#6 Lockwashers	23	3	3	1	1					15	
#6 Flatwashers	17	3	3	2	2					7	(Cable clamps)
Nylon washers	12	3	3	3	3						
Angle Bracket	1									1	(Mtg. No. 6 Board)
Knobs	2									2	
4-40 x ½" screws	14									14	
6-32 x 3/8" screws	11									11	
6-32 x ½" flat-head	4									4	
12 conductor cable	30"									30"	
2 cond. shielded cable	36"									36"	
Hook-up wire	1-coil									X	

Note: Connectors, switches, and mounting hardware for the AK-1 and 425 Hz Discriminator are furnished with the respective kits and are not included in the ST-6 kit.

HAL Communications Corp. October 1973

ADDITIONS & CORRECTIONS TO ST-6 MANUAL

1. Ref. Page 44:

   Total number of .001 uf disc capacitors should be 8. Increase the number used on cabinet to 7.

2. Ref. ST-6 Wiring Diagram:

   Note the use of .001 uf disc capacitors at: audio input jack, remote jack, key jack and FSK jack. Please correct the schematic diagrams to include these capacitors.

3. Ref. Page 45:

   Of the three 2 circuit jacks ($\frac{1}{4}$"), one has a shorting bar which should be used for the printer jack.

4. This Manual applies to factory wired ST-6's serial number 168 and above.

5. This manual applies to ST-6 Kits shipped after November 1, 1973.

6. Ref. Page 19, last paragraph:

   Lines 5 and 6 should read: ". . . cards facing left are numbered from 1 to 12 (top to bottom), and cards facing RIGHT are lettered . . .".

7. Ref. Page 27:

   Ckt Bd 1 - 850 should have pin 11 labeled with -12v (ie. same as pin 11, ckt bd 1 - 170).

   Add bypass capacitor (0.001uf) across audio input.

   Pin 10 of ckt bd 2 - 850 should be labeled -12v as above.

8. Ref. Page 28, Ckt. Bd. 4:

   R424 should be removed from pin L and connected to the +12v buss.

   The common connection of D403, D405, and D408 should be connected to pin L.

The pin connected to the SLOW position of Autostart response switch S4A should be labeled "F".

The position of switch S6 connected to pin C of ckt bd 4 should be relabeled as "MOTOR".

Switch S6 should be labeled as "MOTOR".

Switch S5 should have the label "MOTOR" deleted.

The position of switch S5 connected to pin H, ckt bd 4 should be relabeled as "AUTO OFF".

Add bypass capacitor (0.001 uf) across remote jack, J4.

9. Ref. Page 29. Ckt Bd 5:

Add bypass capacitor 0.001 uf across FSK output jack J5.

Add bypass capacitors (0.001 uf) from tip of CW-ID key jack J6 to ground.

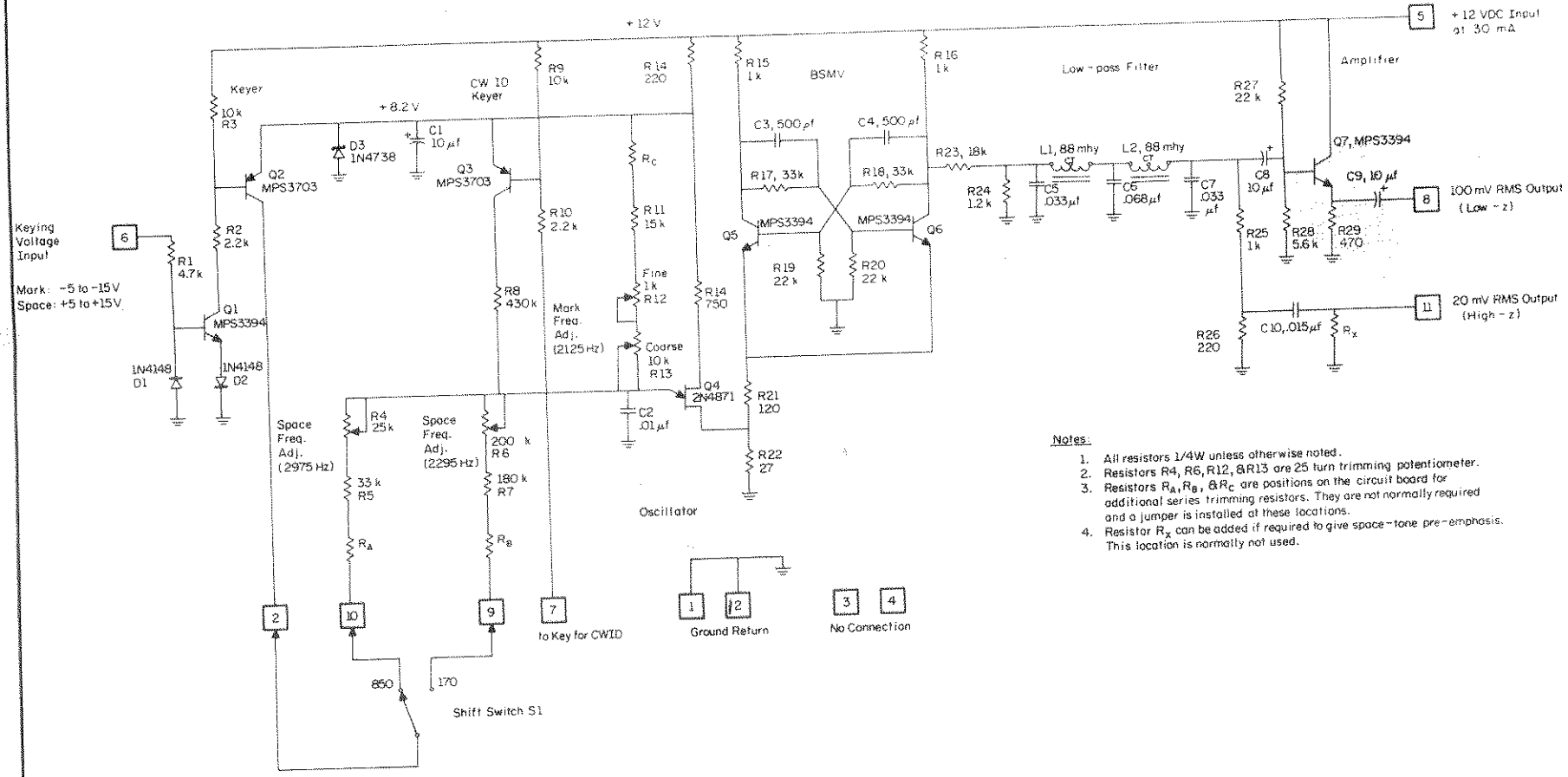
10. Ref. ST-6 Wiring Diagram, ST-6 W1:

AK-1 output jacks should read:

BLK
AK-1 (pin 8)

and

WHT
AK-1 (pin 11)



Notes:

1. All resistors 1/4W unless otherwise noted.
2. Resistors R4, R6, R12, & R13 are 25 turn trimming potentiometer.
3. Resistors R_A, R_B, & R_C are positions on the circuit board for additional series trimming resistors. They are not normally required and a jumper is installed at these locations.
4. Resistor R_X can be added if required to give space-tone pre-emphasis. This location is normally not used.

COMMUNICATIONS CORP.
BOX 365, URBANA ILLINOIS, 61801

AK-1 AFSK Oscillator

DATE	July 13, 1972	SCALE	——
APPROVED		No.	AK-1, S

HAL COMMUNICATIONS
AK-1 RTTY AFSK Generator
Parts List

Resistors

1 - 27 ohm
1 - 120 ohm
2 - 220 ohm
1 - 470 ohm
1 - 750 ohm
3 - 1 K
1 - 1.2 K
2 - 2.2 K
1 - 4.7 K
1 - 5.6 K
2 - 10 K
1 - 15 K
1 - 18 K
3 - 22 K
3 - 33 K
1 - 180 K
1 - 430 K

Capacitors

2 - 500 pf disc.
4 - 0.001 uf disc ceramic
1 - 0.01 uf polystyrene
1 - 0.015 uf mylar
2 - 0.033 uf mylar
1 - 0.068 uf mylar
3 - 10 uf @ 15 V electrolytic

Semiconductors

2 - silicon signal diodes 1N4148
1 - 1N4738 Zener diode
4 - MPS3394 NPN transistor (Q1,Q5,Q6,Q7)
2 - MPS3703 PNP transistor (Q2,Q3)
1 - 2N4871 unijunction transistor (Q4)

Trim-pots

1 - 1 K (2125 Hz fine adj.)
1 - 10 K (2125 Hz coarse adj.)
1 - 25 K (2975 Hz adj.)
1 - 200 K (2295 Hz adj.)

Miscellaneous

1 - 3" x 6" Circuit Board
1 - 12 pin Cinch 50-12A-20 Edge Connector
3 - phone jacks & plugs (AF outputs and Keyed TTY input)
1 - ¼" phone jacks (Hand-key)
2 - 88 mhy toroids
1 - DPDT toggle switch (shift switch)
2 - 6-32 screws, 1" L
2 - 6-32 nuts
2 - #6 lockwashers
2 - #6 flatwashers
2 - nylon insulating washers
1 - Manual

MAINLINE AK-1 AFSK OSC.

HAL COMMUNICATIONS

Notes: 1. Most components are vertically mounted. A "v" next to a pad denotes that the component there is vertically mounted with the component body over the pad designated "v".

2. R_a, R_b, and R_c are normally jumpers. The locations are provided for trimming if necessary.

3. R_x is normally not used.

Fine 2125 Hz

Coarse

2295 Hz

2975 Hz