KB-1D

KIT

INSTRUCTION MANUAL

HAL KB-ID1 KEYBOARD IDENTIFIER

The HAL KB-ID1 is an automatic identifier for use with the MKB-1 Morse keyboard.[1] Designed for installation in the keyboard cabinet, it automatically transmits the station call sign (preceded by the letters "DE") whenever the "HERE IS" key is pressed. In addition, two other keys can each be programmed to transmit a two- or three-character code group. For example, one of the keys might be programmed to transmit "CQ", and the other to send "QTH". When either of these keys is used for a two-character group, the extra capacity is used to transmit a space following the desired characters.

The KB-ID1 is essentially an electronic "key puller." Its outputs are transistor switches which close in sequence when the identifier is activated. These switches are wired in parallel with the MKB-1 keyswitches for the characters to be sent. Thus, these keys are, in effect, pulled down in sequence whenever the "HERE IS" key (or one of the two other preprogrammed keys) is pressed.

Since the identifier simply provides a means for automatically activating the regular keyboard character generating circuitry, no special matrix or other type of memory element is required. Programming the identifier for the desired groups of characters is merely a matter of connecting the identifier outputs to the appropriate keyswitches.

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[1] The KB-ID1 may also be used with the Touchcoder II; see section 6.

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2 OPERATING THE IDENTIFIER

Operating the MKB-1 Morse Keyboard with the KB-ID1 Identifier installed is very little different from normal operation, except that you will be able to transmit your station call sign or either of the two special character groups with a single keystroke.

To send the station call sign, depress the "HERE IS" key at the right end of the top row of keys. The identifier will automatically produce the letters "DE", a space, and the call letters. If the key is released during the "DE" but before the call-letter sequence has started, only the "DE" will be sent. If the key is released after the "DE", but while the call sequence is in progress, the call sign will be completed and the keyboard will return to normal operation. Holding the key down at the completion of the last character of the call will cause the call letters to be repeated. The letters "DE" will not repeat, however--they will be sent only once, after the initial keystroke.

Either of the three-character groups may be transmitted by depressing one of the keys at the right end of the second and third rows of keys. The character group will repeat if the key is held down when the last character is completed. If the key is released before the end of the character group, the sequence will be completed and the identifier will become inactive.

When one of the identifier groups is being sent, depressing either of the other two identifier keys will have no effect. Pressing one of the regular character keys, however, may cause an error.

With the identifier installed in your keyboard, you may find that the keyboard is inoperative when the power is first switched on. If so, release the keyboard by pressing the "CLEAR" key at the left end of the bottom row of keys.

Since there is no way to predict what state the identifier counters will assume when the power is switched on, they may be set initially to a "forbidden" state. Should this occur, the keyboard will function properly but the identifier will not. To reset the identifier to the inactive condition, press any of the regular character keys five or six times in succession. The counters will advance and the identifier will then be ready for operation.

2 PRINCIPLES OF OPERATION

The KB-ID1 logic circuitry consists of three sections. Two of these are identical; they produce the three-character groups. The third section, somewhat more complex, generates the DE-plus-call sign sequence.

Generating the Three-Character Groups

The three-character circuits are each made up principally of two flip-flops (wired as a two-bit counter), a decoder, and three switching transistors, as shown in the schematic diagram (Figure 5). The input of each circuit is wired to a spare keyswitch on the MKB-1 keyboard.

The circuit is activated by closure of the keyswitch, which is connected to an input invertor (one section of IC-1). Since the keyswitch is normally open, the invertor input is held in the high state (about +5 volts) by a 470-ohm resistor connected from the input to the +5 volt supply. The invertor output is therefore normally low (less than +1 volt). When the keyswitch is closed the invertor input goes low, driving the output high.

The invertor output is fed to one input of a NAND gate (IC-2). The other gate input is used to sense whether any of the other identifier sections is active. If not, the second NAND gate input is held high. With the keyswitch closed, both inputs are high and the gate output terminal goes low. This signal resets the two counter flip-flops to zero.

The outputs of the counter flip-flops are supplied to a one-of-four decoder composed of four NOR gates. These gates decode the binary number stored in the counter. As the stored number increments (increases by one), the four NOR gate outputs go high sequentially.

For example, when the counter has been reset by pushing the keyswitch, the normally true outputs of the flip-flops (pins 9 and 12) are both low. These outputs are fed to the inputs of the first NOR gate (pins 8 and 9). With both of the gate inputs low, the output is high. Since at least one of the inputs to each of the other three gates is high, all of the other gate outputs are low.

When the counter increments to a "1", the inputs of the second NOR gate are both low and the output goes high. The other NOR gate outputs are low. As the counter continues to increment, the third gate output goes high, followed by the fourth.

The outputs of the first three decoder gates are fed to keying transistors. The collectors of these transistors are wired in parallel with the keyswitches corresponding to the characters to be transmitted.

In normal keyboard operation the keyswitch contacts short a keying line to ground when the key is pressed. During identifier operation the switching transistors perform the same function when they are driven into conduction by a positive voltage on their base terminals. Thus the keys to which the transistors have been connected are, in effect, "pulled down" in sequence as the counter increments.

When the circuit has been activated and the counter reset to zero, the first keying transistor conducts and the first character is initiated, causing the MKB-1 character clock line to go low. Since this line is connected to the toggle terminal of the first counter flip-flop, the transition from high to low causes the counter to increment to a stored value of 1. The second keying transistor is therefore driven into conduction.

When the first character is completed, the MKB-1 senses this second key closure and initiates the second character of the group. The character clock line, which goes high at the completion of each character, is again driven low and the counter increments once more, this time to a stored value of 2. The process is repeated until all three characters have been sent.

During the transmission of the three characters, the output of the fourth NOR gate in the decoder circuit has remained low. This signal, fed through a three-input NAND gate (IC-3) and an invertor, drives the INHIBIT line, which in turn is connected to the two-input gate at the counter reset terminals. With this terminal held low, the counter cannot be reset by additional closures of the activating keyswitch. Consequently, the counter cannot be reset while a code group is being sent.

As soon as the third character has been initiated, the counter increments to a value of 3, causing the output of the fourth NOR gate to go high. If the activating keyswitch is closed, the counter will now be reset to zero and the entire code group will be repeated. The sequence will repeat as long as the keyswitch remains closed.

Note that the INHIBIT line is also connected to the other two character-generating sections of the KB-ID1. As a result, neither of the other character groups can be activated until the first group has completed its sequence. Similarly, signals are fed to the INHIBIT line from the other two sections. When any one of the sections is active the other two are locked out.

The circuit which produces the second of the three-character groups is identical to that just described.

Generating the Call Sign Sequence

The third section of the KB-ID1 circuitry automatically produces the letters "DE" plus the station call sign whenever the "HERE IS" key is pressed. It operates on the same principles as the three-character-group circuits, but is somewhat more complex, since a larger number of characters must be transmitted. As before, the character string repeats as long as the keyswitch is held closed. Because it is desirable not to repeat the letters "DE", however, the portion of the circuit which keys them is locked out during repetitions of the call sign.

The "HERE IS" circuit employs two separate counters. The first, a two-bit counter, keys the letters "DE". As in the three-character circuits, its outputs are decoded by NOR gates and used to drive transistors wired in parallel with the D and E keyswitches.

The second counter, which produces the call sign, has a capacity of four bits and can therefore count from zero through 15. The first ten states are decoded by a ten-line integrated circuit decoder. As the counter increments through its first ten states, the ten decoder output lines go low sequentially. The lines directly drive the keyswitches corresponding to the characters of the station call sign.

The DE-inhibit circuit, a flip-flop composed of two cross-coupled NAND gates, prevents the letters "DE" from being sent more than once for each closure of the "HERE IS" keyswitch.

The "HERE IS" keyswitch is connected through an invertor (pins 3 and 4 of IC-1) and a NAND gate (pins 1,2,3, and 12 of IC-3) to the reset terminals of the DE-counter flip flops. When the key is pressed, the invertor input goes low, driving the first input of the NAND gate (pin 1) high. The DE-inhibit flip-flop is in the reset state with its output (pin 3 of IC-2) high, making the second input of the NAND gate (pin 2) high. The INHIBIT line is fed to the third input (pin 3) of the NAND gate. If neither of the three-character circuits is active at the time, this input will also be high.

With all of its inputs high, the NAND gate output goes low, resetting the DE-counter to zero. The output of the second counter flip-flop (pin 12 of IC-6) goes low, driving the set terminal of the DE-inhibit flip-flop (pin 3 of IC-3) low. The latter flip-flop changes to the set condition and remains in that state until the "HERE IS" key is released.

The signal from pin 12 of the counter flip-flop is also fed through a two-input NAND gate (pin 4 of IC-2) and an invertor to the NAND gate (IC-3) which drives the INHIBIT line. The line goes low, preventing either of the three-character counters from being activated while the "HERE IS" circuit is operating.

As in the three-character circuits, when the counter is reset the output of the first decoder NOR gate (pin 10 of IC-9) goes high, initiating transmission of the letter "D". The character clock line goes low, toggling the counter to the "1" state, and the second NOR gate output goes high. When the "D" has been completed, the MKB-1 senses the closure of the "E" keyswitch and starts generating the letter "E". The character clock line goes high momentarily between characters and low again when the letter "E" starts. As a result, the counter toggles to the "2" state. Pin 4 of IC-2 goes high again, allowing the INHIBIT line to return to the high state momentarily.

If the "HERE IS" key is still held down, the output of its invertor remains high. With the INHIBIT line high, neither of the diodes connected to the reset terminal of the four-bit counter (pins 2 and 3 of IC-10) conducts. The reset terminal is pulled high by its 1000-ohm pullup resistor and the counter resets to zero.

Character clock pulses from the MKB-1 are fed to the four-bit counter through two NOR gates. The first (pins 1,2, and 3 of IC-9) serves simply as an invertor. The second (pins 4,5, and 6 of IC-9) blocks the clock pulses from reaching the counter's toggle terminal (pin 14) until the counter is reset.

This second NOR gate can only follow the clock pulses when the input to pin 6 is low. Until the counter is reset, this pin is held high (and the gate output therefore low) by the inverted signal from the END CODE line. Also, a diode connected between the INHIBIT line and pin 5 of the NOR gate holds the output low whenever the INHIBIT line goes high. Once the counter is reset, both inputs are released and clock pulses can flow to the counter.

Since a space character is required between the letters "DE" and the first character of the call sign, the first output line from the ten-line decoder (pin 1 of IC-11) is connected through a keyboard toroid to produce a space. When the counter is reset to zero, the line goes low and a space is initiated.

As soon as the space character starts, the clock line goes low. This signal, fed through the two NOR gates to the toggle terminal of the four-bit counter, causes the counter to increment to the "1" state. The second output line from the decoder then goes high.

The decoder outputs are connected directly to the keyswitches corresponding to the call sign characters (no driving transistors are needed). Each time the MKB-1 completes a character, the clock line goes high momentarily until the next character is initiated. When the clock line again goes low, the counter increments to the next state and the succeeding decoder output line goes high.

Since different call signs may contain a different number of characters, a means must be provided to stop the counter after the last character has been sent. This function is provided by the END CODE line. Assume that the call sign contains six characters. The first decoder output line is wired through toroid T_0 to produce a space; the next six are connected to the keys of the call sign characters. The next line is connected to the END CODE invertor terminal (pin 5 of IC-1). After the last call character has started, the counter increments once more and the END CODE line goes low. The invertor output (pin 6) goes high, driving the INHIBIT line to the high state and stopping the flow of clock pulses through the NOR gate at the counter toggle input.

The state that the identifier counters will assume when the power is first switched on is not predictable. It is therefore possible that one of the remaining unused decoder output lines will be low. If that should happen, the counter will not reset when the identifier activating keys are depressed. To reduce this possibility, the unused decoder outputs are all tied to the END CODE terminal.

After the call sign sequence has been completed, if the "HERE IS" key has been released its invertor output (pin 4 of IC-1) will be low, holding the four-bit counter reset line low and preventing the counter from resetting to zero. The process then stops and the keyboard is released for manual operation or for automatic transmission of one of the three-character groups.

If the "HERE IS" key has been held down, however, the four-bit counter is reset and the call sign is repeated. Since the DE-inhibit flip-flop has not been reset, the second input of the NAND gate at the two-bit counter reset terminal remains low, preventing the counter from resetting. Therefore, the call sign is repeated but the letters "DE" are not. The DE-inhibit flip-flop does not reset until the "HERE IS" key is released (driving the flip-flop reset input--pin 2 of IC-2--low) and the call sign sequence has been completed.

3 CONSTRUCTING THE KB-ID1 KIT

Building the KB-ID1 is simply a matter of soldering the components in their proper positions on the circuit board, preparing the cable which connects the board to the MKB-1 boards, and installing the mounting hardware.

Before beginning construction, check the parts supplied against the parts list to make certain that the kit is complete. Report any shortages to the factory.

When soldering the components to the circuit board, use a low-wattage, pencil-tip iron and small-gauge, resin-core solder. Heat the connections only long enough for the solder to flow and "wet" the surfaces of both the component lead and the circuit board pad. Excessive heat may damage the components or cause the printed conductors to separate from the epoxy-glass board surface. Also, be careful not to allow solder to bridge across adjacent printed conductors.

The KB-ID1 assembly drawing, Figure 4, is a view of the circuit board from the component side showing the position of all parts. Using the drawing as a guide, perform the following steps:

1. Insert the eleven integrated circuits, one at a time, and solder the leads. Note that the IC's have an identifying mark at the end nearest pins 1 and 14. The mark may be U-shaped, as shown, or may be a dot or other distinctive mark, depending on the manufacturer. Be sure to position the mark as shown in the drawing. When soldering, use a low-wattage iron and be careful not to allow solder to bridge between adjacent pins.

2. Insert the eight transistors in their mounting holes near the left edge of the board and solder the leads. Be sure to position the flat side of the transistors as shown in the drawing. Trim off the excess lead length, if any.

3. Insert the five diodes in the positions shown. Observe polarity--the cathode end of the diode (the end to which the colored bands are closest) connects to the square pad on the circuit board. Solder all leads and trim off excess length.

4. Insert the 15 resistors and solder the leads. Position the 1000-ohm resistor near IC-1 (at the upper right edge of the board) so that it does not obstruct the circuit board mounting hole.

5. Insert the five disc ceramic capacitors and solder the leads. Capacitor positions are denoted by ovals on the drawing. Trim off the extra lead length.

6. Insert the 47 μFd electrolytic capacitor with its positive lead connected to the square pad. Solder and trim both leads.

7. Next, prepare the leads which connect the board to the MKB-1 circuitry. The 24 wires are divided into five separate bundles according to the following tables. Cut each lead 19 inches long and strip ¼ inch of insulation from both ends. Use lacing cord or tape to hold each bundle together temporarily. Insert the wires in the circuit board holes listed in the tables and solder. Hole numbers are shown in Figure 1 and are printed on the board itself. Trim off any excess lead which protrudes through the board.

Bundle 1

Color	Hole #
Red	25
Blue	26
Yellow	2
Green	3
Gray	4
White	5

Bundle 4

Color	Hole #
Red	14
Yellow	15
White	16
Blue	17
Green	18
Gray	19

Bundle 2

Color	Hole #
Red	6
Blue	7
White	8
Yellow	9
Gray	10
Green	13

Bundle 5

Color	Hole #
Red	20
Blue	21
Gray	22
White	23
Green	1

Bundle 3

Color	Hole #
Yellow	11
Green	27

Twist these wires together

8. Using 4-40 x ¼" round-head screws and No. 4 lockwashers, fasten the 3/8" standoffs to the board. The screw head and lockwashers should be on the top (component) side of the board; the standoffs mount on the bottom.

Construction of the identifier is now complete. Before proceeding, check all parts locations, wire colors, hole numbers, and solder joints.

4 INSTALLING THE IDENTIFIER IN THE MKB-1 KEYBOARD

The KB-ID1 identifier circuit board mounts on the inside of the MKB-1 bottom cover. Four predrilled holes are provided for the mounting screws.

Disconnect the MKB-1 power cord and remove the bottom cover. Position the identifier board over the four predrilled holes, orienting it so that the connecting leads are nearest the speaker. Do not fasten the board to the cover yet.

The leads from the identifier board must now be connected to the proper points on the MKB-1 circuit boards. Since the wiring will depend on the characters the identifier is "programmed" to send, decide first what characters you would like each of the three-character groups to send and enter them in the "character" column in the tables below. If you wish, you may program the groups to include word spaces along with the normal characters (letter spaces are generated automatically by the keyboard). For two-character groups, programming a word space after the second character ensures proper spacing when the group is repeated by holding the key down.

First Three-Character Group

Character Number	Character	Wire Bundle	Color
1		5	Red
2		4	Gray
3		4	Green

Second Three-Character Group

Character Number	Character	Wire Bundle	Color
1		4	Blue
2		4	White
3		4	Yellow

Now enter the call letters in the following table exactly as you wish them transmitted. The call sign may consist of up to 8 characters and may include a "/" followed by a number to indicate a portable station. Note that a space character should always precede the call to provide proper spacing after the letters "DE". In all of the blanks after the last character of the call, write the words END CODE.

Call Sign Group

Character Number	Character	Wire Bundle	Color
1	SPACE	2	Gray
2		2	Yellow
3		2	White
4		2	Blue
5		2	Red
6		1	White
7		1	Gray
8		1	Green
9		1	Yellow
10		5	Green

The wires listed in these tables will now be connected to the proper keyswitches. Figure 1 shows a bottom view of the MKB-1 keyswitch circuit board. Each keyswitch has two terminals. The grounded contacts of the switches are connected to a printed ground bus which runs along the front-panel edge of the circuit board. The "hot" side of the switches are connected by printed conductors to a row of pads near the toroid mounting holes.

The wires from the identifier are connected to the "hot" side of the switches. Connect each wire by laying it along the conductor strip leading to the pad for the appropriate switch and soldering it in place.

Starting with the table for the first three-character group, connect the wire corresponding to the first character (the red wire in bundle 5) to the keyswitch for that character. Proceed in the same manner for the second and third characters in the first group.

For example, if you have decided to use the first group to transmit "QTH", connect the red wire in bundle 5 to the "Q" keyswitch, the gray wire in bundle 4 to the "T" keyswitch, and the green wire in bundle 4 to the "H" keyswitch.

If you wish to include a space as one of the characters, do not connect the wire for that character to a keyswitch. Instead, route it to the top side of the keyswitch board, pass it through toroid T_0, and solder it to the bundle of leads connected to hole QQ or RR, as shown in Figure 1. It will be necessary to remove the four screws holding the keyswitch board in place and lift the board gently away from the cabinet to gain access to the toroid wiring.

Follow the same wiring procedure for the other three-character group and the call sign group. Note that you may have more than one wire connected to some of the keyswitch pads, depending on the characters you have chosen to program.

When you reach the END CODE line in the call sign table, connect the wire listed there back to hole 24 in the identifier board (rather than to a keyswitch). This wire may be cut just long enough to reach through the hole. The other wires in this table will not be used.

After these connections have been made, reinstall the four screws which hold the keyswitch board in place.

Now, referring to Figure 1, install the three wires which connect the activating keyswitches to the KB-ID1 inputs:

1. Connect the gray wire of bundle 5 to the GROUP 1 keyswitch.

2. Connect the blue wire of bundle 5 to the GROUP 2 keyswitch.

3. Connect the white wire of bundle 5 to the HERE IS keyswitch.

The leads which supply power to the identifier are also connected to the keyswitch board:

1. Connect the blue wire of bundle 1 to the +5 volt bus which runs along the top edge of the board near the toroids, as shown in Figure 1. Lay the tinned end of the wire along the printed bus and solder it in place.

2. Place the power supply ground lead (red wire, bundle 1) against the ground bus near the bottom edge of the board and solder it in position.

The two remaining wires connect to the keyer circuit board (the 3 x 6" board mounted on the rear panel). Remove the two screws which hold the board in place and gently swing the board away from the cabinet to provide access to the printed side. Then, referring to Figure 2, make these connections:

1. Insert the green wire of the green-and-yellow twisted pair (bundle 3) in hole 27. Solder it and trim of the excess. Be careful to prevent solder from bridging to adjacent conductors.

2. Insert the yellow wire of the twisted pair into hole 28, solder, and trim off excess.

The circuit board may now be reinstalled on the rear panel.

The wiring is now complete. Carefully recheck all solder connections and wire colors. Using lacing cord, securely lace all of the wire bundles except the twisted pair.

Fasten the identifier board to the bottom cover with 4-40 x ¼" round-headed screws and No. 4 lockwashers. The lockwashers should be placed on the outside of the cover under the screwheads, not under the standoffs.

Reinstall the bottom cover of the MKB-1, carefully positioning the wire bundles so that they are not pinched between the cover and the main cabinet.

With the keyboard in the normal operating position, label the identifier activating keys. The "HERE IS" key is the last key at the right end of the top row; the first three-character-group key is at the right end of the second row from the top. The other three-character key is at the right end of the third row down.

The installation of the identifier is now complete. Refer to Section 2 of this manual for operating instructions.

5 REPAIRS AND WARRANTY

Should you encounter difficulty with your identifier, the checks listed here may help to localize the difficulty.

1. With the AC line cord disconnected, use an ohmmeter to check for ground continuity between the identifier board and the ground bus on the keyswitch board.

2. Supply AC power to the keyboard and turn the power switch on.

   CAUTION: 117 volts AC is exposed at several points inside the keyboard housing.

   Measure the voltage at terminal 26 of the identifier board. It should read 5.0 $\pm$0.2 volts. If it does not, check for a blown fuse, a fault in the wiring between the keyboard power supply and the identifier, a short on the identifier circuit board, or failure of the MKB-1 power supply.

3. If the power supply voltages are correct, refer to Section 3 of this manual for a description of the identifier's normal operating conditions. Starting with the activating keyswitches, trace the signal through the identifier, using a voltmeter or oscilloscope to indicate high and low states. With TTL logic, the high state is normally greater than +4 volts. The low state is less than 1 volt. When connecting the voltmeter or scope probes, be careful not to short between adjacent circuit pins or printed conductors.

As noted in Section 2, the keyboard may be inoperative when the AC power is first switched on. To release the keyboard, press the "CLEAR" key. Be sure to check that the "CLEAR" key has been pressed before concluding that the identifier or keyboard is malfunctioning.

If you encounter difficulties that you are unable to eliminate, you may return the keyboard with the identifier installed to the factory for service, as outlined in the warranty below.

WARRANTY

HAL Communications Corp. warrants that all factory-assembled KB-ID1 Keyboard Identifiers shall be free of defects in materials and workmanship under normal use and service for a period of one year from the date of the original invoice, and further warrants that all parts supplied with KB-ID1 kits shall likewise be free of such defects for the same period.

Should such defects occur within the warranty period, notify HAL Communications Corp. promptly in writing. The notification letter must be postmarked prior to one year from the date of the original invoice. Please do not return your unit to the factory for repair until you have sent a letter of notification and have received a written return authorization.

Identifiers or parts returned to the factory under warranty will be repaired or replaced at no charge except for transportation costs.

Please be sure to send the identifier installed in the keyboard, as the difficulty may be caused by interaction between identifier and keyboard circuits.

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 keyboard.

The foregoing warranty is completely void on all identifiers or parts thereof which have been damaged, abused, modified, or improperly installed or operated.

6 USING THE IDENTIFIER WITH TOUCHCODER II KEYBOARDS

The KB-ID1 identifier may be used with Touchcoder II keyboards if desired. All connections to the keyboard are the same as for the MKB-1, except for the following:

1. The character clock signal supplied to terminal 11 of the identifier circuit board is taken from base 1 of the MU4892 transistor in the keyboard. Add a 1000-ohm resistor between the transistor base terminal and the +3.9 volt keyboard power supply.

2. Since the KB-ID1 requires a supply voltage of +5.0 volts DC at 200 mA., the power supply in the Touchcoder II cannot be used to provide power to the identifier. A separate supply, such as that shown in Figure 3, must be provided. The +5 volt terminal of the supply is connected to identifier terminal 26 (blue wire, bundle 1); terminal 25 (red wire, bundle 1) is connected to the supply ground.

7 PARTS LIST AND SCHEMATIC DIAGRAM

Resistors

8	270 ohm, ¼ watt
3	470 ohm, ¼ watt
4	1000 ohm, ¼ watt

Capacitors

1	.001 ufd 1 kV disc ceramic
1	.01 ufd 50 V disc ceramic
1	.05 ufd 50 V disc ceramic
1	.22 ufd 12 V disc ceramic
1	47 ufd 16 V electrolytic

Semiconductors

5	1N270 diodes
8	MPS3394 transistors
1	7400 integrated circuit
3	7402 integrated circuits
1	7404 integrated circuit
1	7410 integrated circuit
1	7445 integrated circuit
3	7473 integrated circuit
1	7493 integrated circuit

Miscellaneous

1	KB-ID1 printed circuit board
8	4-40 x ¼" screws
8	No. 4 lockwashers
4	3/8" threaded standoffs
	hookup wire, six colors

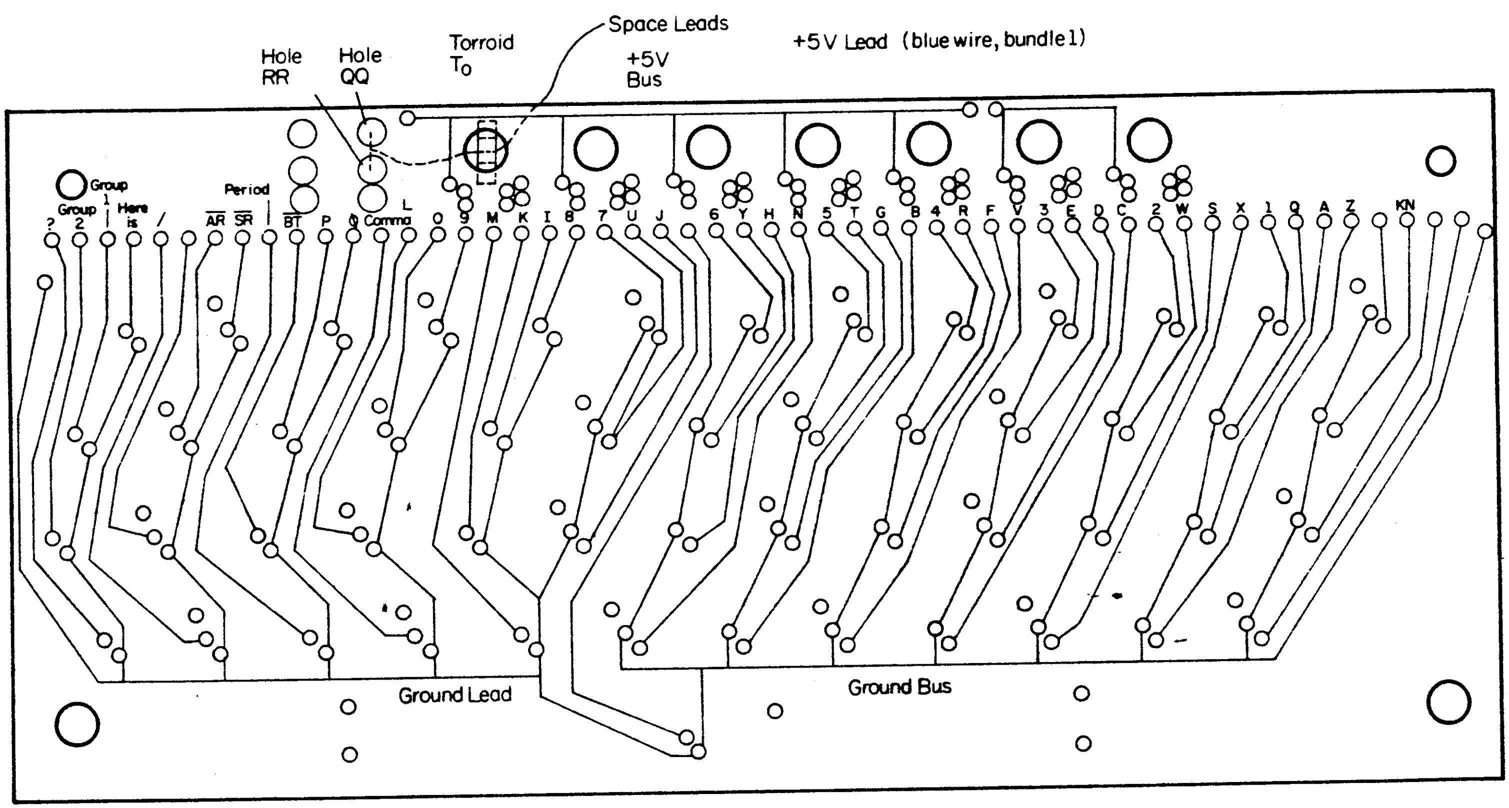

Fig. 1 MKB-1 Keyswitch Board (bottom view)

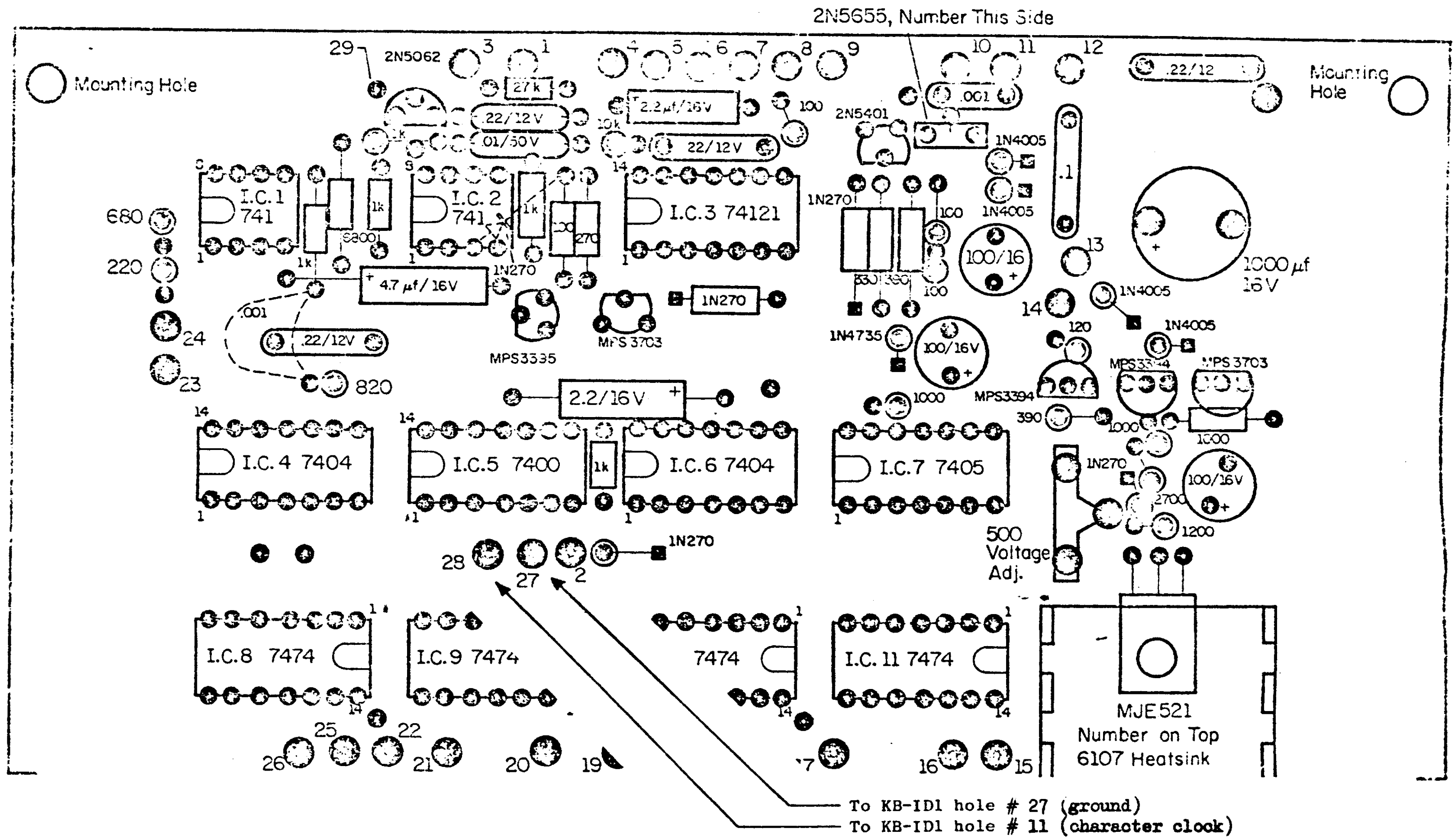

Figure 2. MKB-1 logic circuit board (component side) showing location of KB-ID1 connection points.

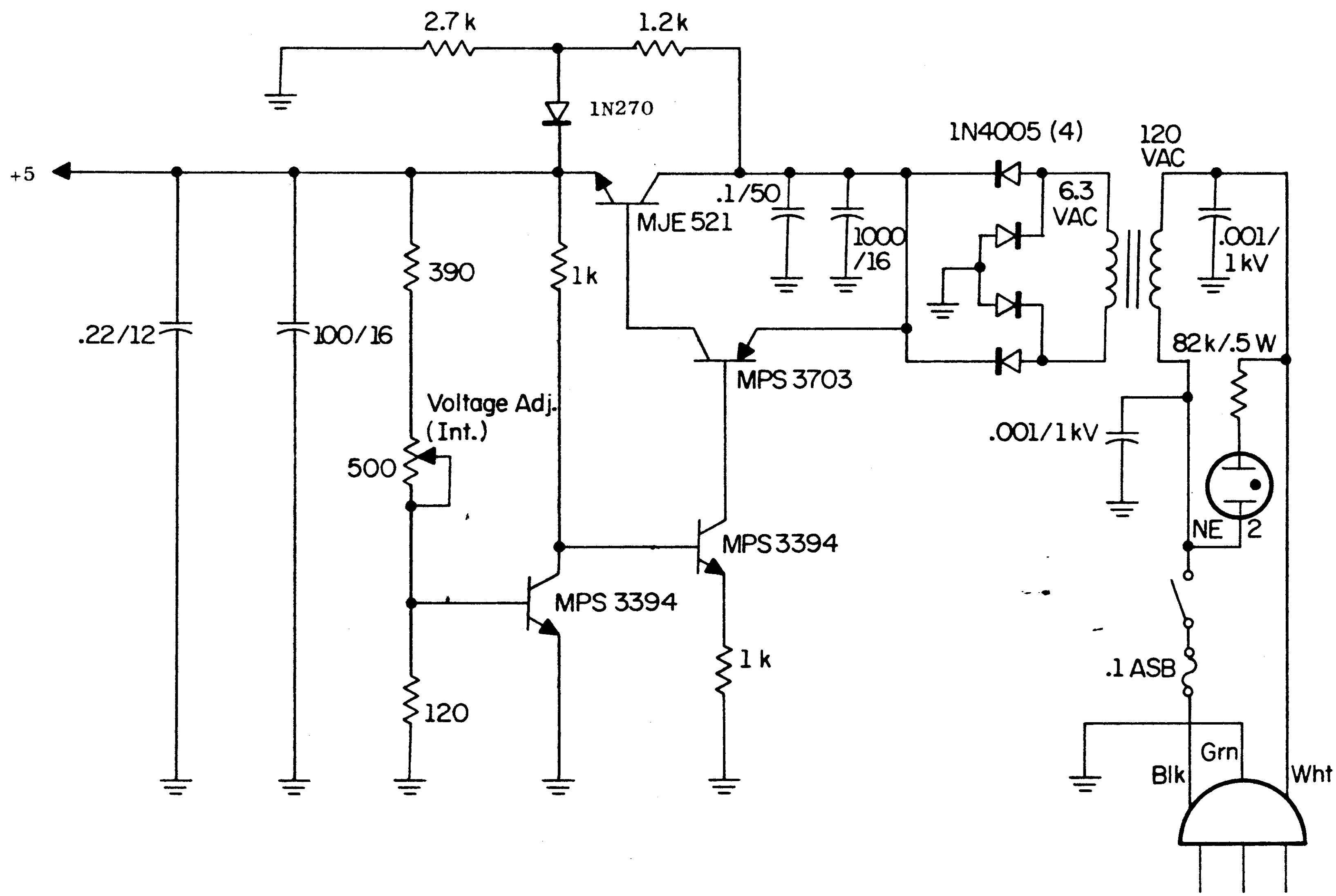

Figure 3. Typical 5 volt regulated power supply.