# KBD-5 KEYBOARD

## General Description

The KBD-5 keyboard and ASCII encoder utilizes a single MOS intergrated circuit to perform the bulk of all necessary operations to generate full 8 bit parallel ASCII output code complete with a parity bit for error detection. Debounce is internal and automatic and choice between positive or negative keypressed output strobe is provided. The keyboard can be programmed for upper case characters only, or upper and lower case characters. The KBD-5 has the features of n key lockout and 2 key rollover to help in reducing typing errors. Once a key is pressed pressing other keys will have no effect until the first key is released. The KBD-5 is already programmed for the control functions LINE FEED, RETURN and ESCAPE and can easily be programmed for other control functions. The keyboard also has two SPST locking keyswitches which can be used for turning the RECEIVE, TRANSMIT and ECHO functions of a terminal such as the CT-1024 on and off. The keyboard also has an automatic repeat function which causes a string of characters to be transmitted after a key has been depressed for more than about 0.5 seconds.

## Assembling your Keyboard and ASCII Encoder

NOTE: MOS integrated circuits are susceptable to damage by static electricity. Although some degree of protection is provided internally within the integrated circuits, their cost demands the utmost in care. Before opening and/or installing any MOS integrated circuits you should ground your body and all metallic tools coming into contact with the leads through a 1M ohm 1/4 watt resistor (supplied with the kit). The ground must be an "earth" ground such as a water pipe, and not the circuit board ground. As for the connection to your body, attach a clip lead to your watch or metal ID bracelet. Make absolutely sure you have the 1M ohm resistor connected between you and the "earth" ground, otherwise you will be creating a dangerous shock hazard. Avoid touching the leads of the integrated circuits any more than necessary when installing them even if you are grounded. On those MOS IC's being soldered in place, the tip of the soldering iron should be grounded as well (seperately from your body ground) either with or without a 1 Meg ohm resistor. Most soldering irons having a three prong line cord already have a grounded tip. Static electricity should be an important consideration in cold, dry environments. It is less of a problem when it is warm and humid.

( ) Install the 14 jumpers on the PC board. Use some of the light gauge wire supplied with the kit or excess resistor leads. On the longer jumpers use <u>insulated</u> wire to keep the jumper from shorting to other components. Jumpers are denoted on the circuit board by solid lines connecting two pads. As with all other component installation, unless otherwise noted, pull the jumpers down flush with the circuit board and solder.

( ) Install the resistors and capacitors on the circuit board using the component layout on the board and the parts list. Bend the leads over on the back side of the board and trim so that 1/16" to 1/8" of lead remains. Solder.

( ✓) Install integrated circuits IC2-IC3 on the board. Be sure to orient the IC's as shown on the board and do not bend the leads on the back side of the board. Doing so makes it very difficult to remove the IC should replacement ever be necessary. Do not install IC1 at this time. Solder.

( ✓) Install the transistor and diodes on the board. Leave about 1/4" clearance between the transistor body and the circuit board. Be sure to orient the components exactly as shown on the component side of the board. Solder.

( ✓) Check the key switches with an ohmmeter before they are installed to be sure that they are making contact properly and to be sure that they do not stick. Solder the switches in place one at a time using as little heat as necessary to get a good solder joint. Note that the keyswitches for the RCVE/XMIT and ECHO positions are a SPST switch and are different from the rest. The switches can be recognized by pressing each keyswitch. The SPST switches will have a locking position. Install these two switches first. Be careful not to force any switch into a hole in such a way as to damage the connecting wires. Excessive heating can distort, or even melt the plastic body and ruin the keyswitch. Check the switch again with an ohmmeter for proper operation after soldering it in place. This can save much troubleshooting later. If the switch works properly heat stake the switch in place by melting over the ends of the plastic mounting bosses. This can be done with the tip of your soldering iron.

( ✓) After all keyswitches have been installed and checked you are ready to install the programming strips on the bottom of the board. These strips mount vertically, at right angles to the main board. The etched finger, connection points on the programming strips will match the connection pads on the main board when the strips are in the correct position. Hold one of the strips in the correct position and turn it so that the connection fingers match the pads on both sides of the strip. Note that there are two ways the strip may be turned and only one is correct. If the strips edge is too rough to fit down solidly against the main board, file, or sand that edge flat. Hold, or clamp sides of the strip to the main board, pads. Install the other strip in the same way. Both strips are identical.

( ✓) The spacebar and equalizer assembly goes together as follows. Mount a keyswitch on the board in the center of the spacebar area. Mount the two "L" shaped brackets with a notch in the top on each side of the keyswitch in the holes provided. The side of the bracket with the notch should be next to the circuit board edge. These should be fixed in place by melting and flattenting slightly the plastic pins on the back of the board with your soldering iron tip. Press one of the equalizer wire retainers into place on the end of the spacebar itself. The hole for the wire should be on the more slanted side of the spacebar that has the four casting bumps. Slip the equalizer wire into the hole in the retainer you have not yet pressed into place. Press the second retainer into place. Turn the spacebar upside down in front of the board and press the equalizer wire into the notches in the top of the mounting clips. Turn the spacebar over and position it over the keyswitch in the center of the board. Press it down into place.

( ) Install IC1 following the precautions given for MOS IC's. Solder.

(✓) To finish the keyboard assembly snap the plastic key tops on their respective keyswitch as noted on the key configuration drawing. If some of the keytops are loose you can securely fasten them to the switches by using a small amount of plastic cement. Blank keytops may be supplied for the RCVE/XMIT and ECHO positions.

The programming of the "CASE", "PARITY" and the "KEYPRESSED" jumpers depends on what your keyboard will be used for. For upper case characters only connect a jumper from the pad marked "CASE" to "U". For upper plus lower case connect the jumper from the "CASE" pad to "U + L". For a positive keypressed strobe (KP line normally low, goes high when a key is pressed) connect a jumper from the KP pad to "+", for a negative keypressed strobe (KP line normally high, goes low when a key is pressed) connect a jumper from the KP pad to "-". A jumper for "PAR" should also be installed to its respective "U" or "U + L" pad depending on whether upper case or upper plus lower case characters will be used.

## Notice to CT-1024 Terminal Owners

In order for the KBD-5 to be used on the CT-1024 terminal the keyboard should be programmed for a negative keypressed strobe (KP select jumper connected to -) and for upper case characters only, ("CASE" jumper connected to U). This is the normal programming for other TV TYPEWRITERS but may need to be modified for your particular application. The parity bit is not used in the CT-1024 but the "PAR" jumper should be connected to "U". The terminals R, T and E of J1 can be connected to control the receive/transmit and echo functions of your CT-1024 if a serial interface is installed. Connect R to JS-1 pin 5, T to JS-1 pin 4 and E to JS-1 pin 8 of the serial interface.

## Checkout

The only equipment needed to check the operation of your keyboard is a DC milliammeter and a DC voltmeter. Apply +5 volts, ground, and -12 volts to the proper pins and check for currents of about 4 mA on the -12 line and about 8mA on the +5 line (no keys pressed). If the currents are much higher than this stop immediately and check for parts inserted incorrectly or solder bridges. If the currents check OK check the keypressed output. If the KP select jumper is set for (-) the KP output should be high (4.5V nominal) and go low (0.1 volts nominal) when a key is pressed. If the KP output is held low check for possible solder bridges or a shorted key switch. If the KP select jumper is set for (+) the KP output will be normally low and will go high when a kev is pressed. If all seems well refer to the ASCII code tables supplied and check the outputs of bits 1-7 with your voltmeter for each individual character. Be sure to use the correct table depending on how the "CASE" selector is wired on your keyboard. With the "CASE" selector set for the upper case only the SHIFT control will have no effect on the output code when any letter is pressed but will make bit 5 a 0 when any character of column 3 of Table 1 is pressed. When in the upper case only mode the SHIFT key will not affect any of the characters in columns 4 or 5. Pressing the control key forces bit 7 to be a 0 therefore allowing you to select the operators in columns 0 and 1. When in the upper plus lower case mode the SHIFT key makes bit 6 a 1 when letters of columns

4 and 5 of table 2 are pressed and makes bit 5 a 0 when any character of column 3 is selected. The control key operates as before.

This keyboard uses EVEN parity in both the upper case only and the upper plus lower case modes. The parity bit should be low when the number of zeros in the output code is odd and should be high when the number of zeros is even. For example the ASCII code for X, 0001101, should make the parity bit high. The repeat function should be checked by holding any one key down for more than about 1 sec. The keypressed strobe should switch on and off until the key is released. If a faster or slower repeat rate is desired the value of C6 can be changed slightly.

## Circuit Description

As shown in figure 1 the keyswitches are arranged into a matrix with the X lines from IC-1 outputing test pulses in time sequence and the Y lines sensing their presence. If no key is pressed, IC-1 continuously scans the keys, at a rate of 50,000 keys per second. Whenever a key is closed, the scanning action stops and that location is held by the internal circuitry of the encoder. This location is called an address. This address is routed to an internal fixed memory called a read only memory. In exchange for an address and some information on the status of the shift and control keys the read only memory gives the proper 8 bit ASCII output code, complete with parity.

As soon as the scanning stops, a time delay is started and controlled by R1 and C1. This takes into account any switch closure bounce or noise and makes sure the key is firmly down and not just brushed on the way by. After the delay time, an output "keypressed" strobe is made available. This tells whatever you attach to your keyboard that the code is ready for use and valid.

If a key is released the scanning action starts up again and goes on till a new key is pressed. If two keys are pressed at nearly the same time the first key pressed provides its output code after a debounce delay. When the first key is released, the scanner starts up but only goes around till it hits the other key's location. After a new debounce delay, the second key's code is output. Keys can continue to be pressed in sequence two down at a time forever, with always the right code being output in sequence, and nothing missed or out of order. This most handy feature takes care of sloppy typing and "burst" rate typing where keys are hit fast and furious in sequence.

IC2 and IC3 are used for the automatic repeat function. IC3 is setup as an astable multivibrator that continuously runs at a frequency of approximately 8.5 Hz. When a key is first pressed the KP line of IC1 goes high causing an immediate low output of IC2-C. If the key is immediately released no repeat function is initiated. If the key is held down for more than about 1 second C7 will charge to a point where IC2A is triggered. At this time the output of IC3 is NAND'ed with the KP strobe therefore causing the KP signal to be chopped just as if the key was continously pushed and released. This action will continue until the key is released.

## In Case of Problems

The tests called for in the check-out procedure are designed to warn you of problems before they can cause damage. If any abnormal results are obtained during the tests, or if there is obvious overheating of any part discontinue use until the problem is located and corrected. Experience has shown that most problems are caused by minor wiring, component installation and soldering technique errors which can be prevented by careful assembly.

If you do have problems with your keyboard there are several tests you can perform which may help you locate the problem. You will need an ohmmeter, an oscilloscope, and a DC voltmeter for these tests. First go back and check once more for proper component installation and for solder bridges or cold solder joints. Also be sure that the correct jumpers are in place. Next check each keyswitch with an ohmmeter to be sure none are shorted. If you have an oscilloscope apply power to the keyboard and check for a 50 KHz signal on pin 40 of IC-1. If you obtain no signal check for 5 volts on pin 1, -12 on pin 18 and ground on pin 17.

## Repair Procedure

Repairs will be made on a basic rate charge plus parts. The basic rate for the KBD-5 is $10.00. If you must return your KBD-5 please send the $10.00 in the form of a money order or cashiers check along with the keyboard. When repairs are finished the keyboard will be returned to you COD for parts charges, if any. Do Not send personal checks for repair work.

Pack all parts to be returned carefully and insure. We will not accept delivery on any parcels that arrive in damaged condition. Make check or money order payable to Southwest Technical Products Corporation.

# Parts List - KBD-5 Keyboard

## Resistors

| | |
|---|---|
| R1 | 680K ohm 1/4 watt resistor |
| R2 | 100K " " " " |
| R3 | 150K " " " " |
| R4 | 47K " " " " |
| R5 | 10K " " " " |
| R6 | 680 " " " " |
| R7 | 330 " " " " |

## Capacitors

| | |
|---|---|
| C1, C5 | 0.01 mfd disc capacitor |
| C2 | 47 pf polystyrene capacitor |
| C3, C4 | 0.1 mfd @16 volt disc capacitor |
| C6 | 0.47 mfd tantalum capacitor |
| C7 | 220 mfd @6.3 volt electrolytic capacitor |

## Semiconductors

| | |
|---|---|
| IC1 | 2376 Keyboard Encoder (MOS) |
| IC2 | 74LS00 quad NAND gate |
| IC3 | 555 timer |
| Q1 | 2N5210 NPN silicon transistor |
| D1 - D3 | 1N4148/1N914 silicon diode |

## Misc.

| | |
|---|---|
| J1 | 15 pin Molex edge connector |
| S1-S2 | Keyboard switch, SPST locking |
| S3-S56 | Keyboard switch |
| | PC board, programming jumpers (2), Keytops |

| BIT NUMBERS | | | | | | | | 0 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1 0 0 | 1 0 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $b_7$ ↓ | $b_6$ ↓ | $b_5$ ↓ | $b_4$ ↓ | $b_3$ ↓ | $b_2$ ↓ | $b_1$ ↓ | COLUMN → / ROW ↓ | 0 | 1 | 2 | 3 | 4 | 5 |
| | | | 0 | 0 | 0 | 0 | 0 | NUL | DLE | SP | 0 | @ | P |
| | | | 0 | 0 | 0 | 1 | 1 | SOH | DC1 | ' | 1 | A | Q |
| | | | 0 | 0 | 1 | 0 | 2 | STX | DC2 | " | 2 | B | R |
| | | | 0 | 0 | 1 | 1 | 3 | ETX | DC3 | # | 3 | C | S |
| | | | 0 | 1 | 0 | 0 | 4 | EOT | DC4 | $ | 4 | D | T |
| | | | 0 | 1 | 0 | 1 | 5 | ENQ | NAK | % | 5 | E | U |
| | | | 0 | 1 | 1 | 0 | 6 | ACK | SYN | & | 6 | F | V |
| | | | 0 | 1 | 1 | 1 | 7 | BEL | ETB | ' | 7 | G | W |
| | | | 1 | 0 | 0 | 0 | 8 | BS | CAN | ( | 8 | H | X |
| | | | 1 | 0 | 0 | 1 | 9 | HT | EM | ) | 9 | I | Y |
| | | | 1 | 0 | 1 | 0 | 10 | LF | SUB | * | | J | Z |
| | | | 1 | 0 | 1 | 1 | 11 | VT | ESC | + | . | K | [ |
| | | | 1 | 1 | 0 | 0 | 12 | FF | FS | , | < | L | \ |
| | | | 1 | 1 | 0 | 1 | 13 | CR | GS | - | = | M | ] |
| | | | 1 | 1 | 1 | 0 | 14 | SO | RS | | > | N | ^ |
| | | | 1 | 1 | 1 | 1 | 15 | SI | US | / | ? | O | _ |

Available characters and commands for the UPPER CASE mode

AY-5-2376 Keyboard Encoder

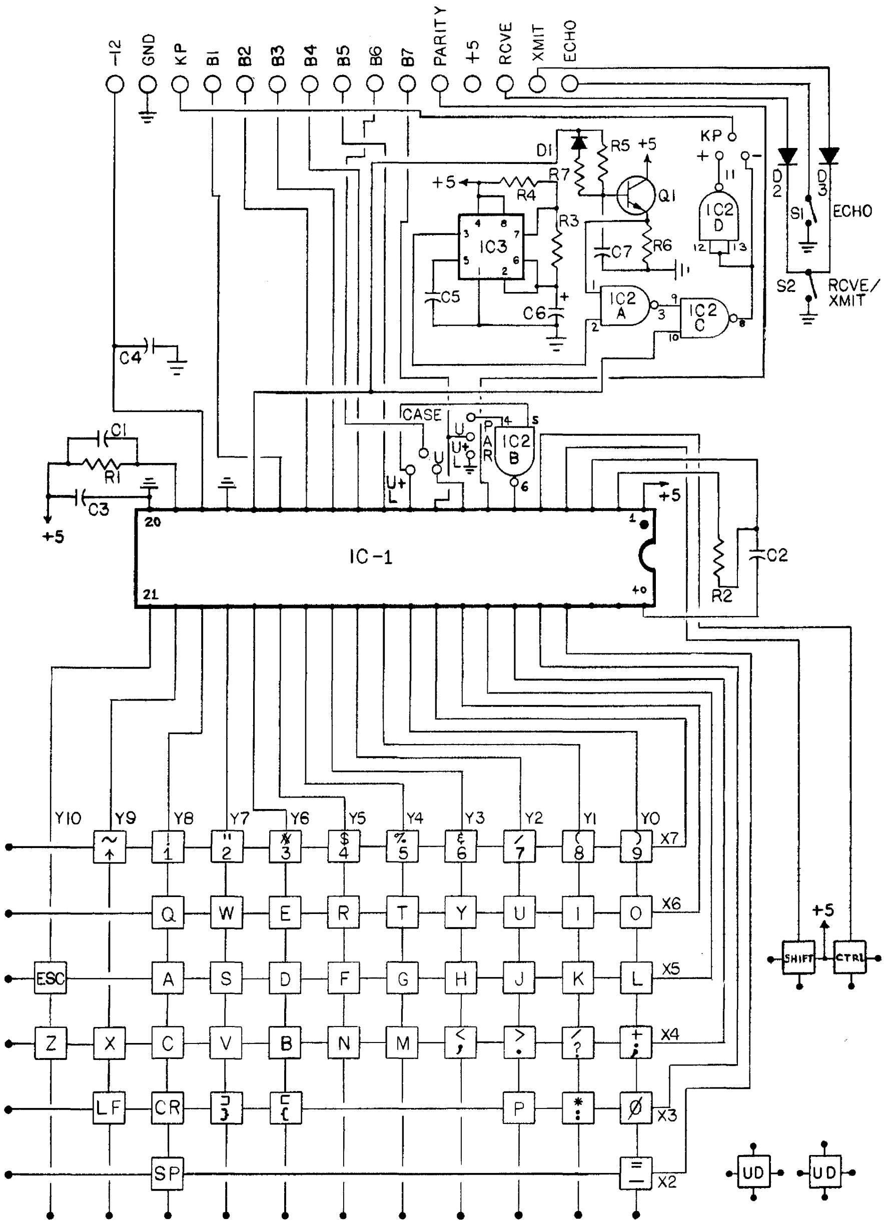
| BIT NUMBERS | | | | | | | | 0 0 0 | 0 0 1 | 0 1 0 | 0 1 1 | 1 0 0 | 1 0 1 | 1 1 0 | 1 1 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $b_7$ ↓ | $b_6$ ↓ | $b_5$ ↓ | $b_4$ ↓ | $b_3$ ↓ | $b_2$ ↓ | $b_1$ ↓ | COLUMN → / ROW ↓ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | | | 0 | 0 | 0 | 0 | 0 | NUL | DLE | SP | 0 | @ | P | \ | p |
| | | | 0 | 0 | 0 | 1 | 1 | SOH | DC1 | ' | 1 | A | Q | a | q |
| | | | 0 | 0 | 1 | 0 | 2 | STX | DC2 | " | 2 | B | R | b | r |
| | | | 0 | 0 | 1 | 1 | 3 | ETX | DC3 | # | 3 | C | S | c | s |
| | | | 0 | 1 | 0 | 0 | 4 | EOT | DC4 | $ | 4 | D | T | d | t |
| | | | 0 | 1 | 0 | 1 | 5 | ENQ | NAK | % | 5 | E | U | e | u |
| | | | 0 | 1 | 1 | 0 | 6 | ACK | SYN | & | 6 | F | V | f | v |
| | | | 0 | 1 | 1 | 1 | 7 | BEL | ETB | | 7 | G | W | g | w |
| | | | 1 | 0 | 0 | 0 | 8 | BS | CAN | ( | 8 | H | X | h | x |
| | | | 1 | 0 | 0 | 1 | 9 | HT | EM | ) | 9 | I | Y | i | y |
| | | | 1 | 0 | 1 | 0 | 10 | LF | SUB | * | | J | Z | j | z |
| | | | 1 | 0 | 1 | 1 | 11 | VT | ESC | + | | K | [ | k | { |
| | | | 1 | 1 | 0 | 0 | 12 | FF | FS | , | < | L | \ | l | \| |
| | | | 1 | 1 | 0 | 1 | 13 | CR | GS | - | = | M | ] | m | } |
| | | | 1 | 1 | 1 | 0 | 14 | SO | RS | | > | N | ^ | n | ~ |
| | | | 1 | 1 | 1 | 1 | 15 | SI | US | / | ? | O | - | o | DEL |

Available codes and characters for the UPPER PLUS LOWER CASE mode

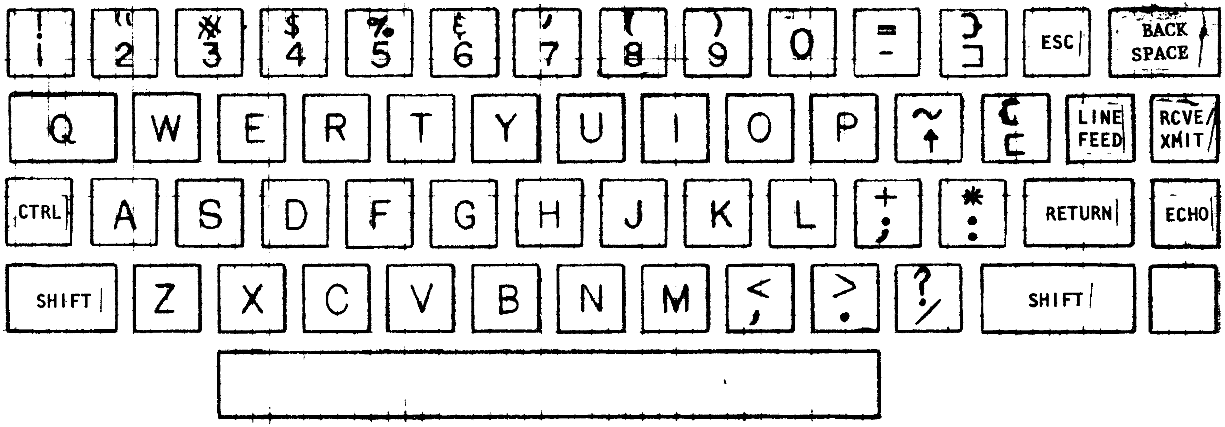
AY-5-2376 Keyboard Encoder

| CONNECT → / TO OBTAIN ↓ | | $X_0$ | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ |
|---|---|---|---|---|---|---|---|---|---|
| $Y_0$ | NORMAL | NUL | DLE | - | Ø | ; | l | o | 9 |
| | SHIFT | NUL | DLE | = | NUL | + | L | O | ) |
| | CONTROL | NUL | DLE | NUL | NUL | NUL | FF | SI | NUL |
| $Y_1$ | NORMAL | SOH | K | FS | | / | k | i | 8 |
| | SHIFT | SOH | [ | FS | * | ? | K | I | ( |
| | CONTROL | SOH | VT | FS | NUL | NUL | VT | HT | NUL |
| $Y_2$ | NORMAL | STX | L | GS | p | | j | u | 7 |
| | SHIFT | STX | \ | GS | P | > | J | U | ' |
| | CONTROL | STX | FF | GS | DLE | NUL | LF | NAK | NUL |
| $Y_3$ | NORMAL | ETX | N | RS | _ | , | h | y | 6 |
| | SHIFT | ETX | ^ | RS | DEL | < | H | Y | 8 |
| | CONTROL | ETX | SO | RS | US | NUL | BS | EM | NUL |
| $Y_4$ | NORMAL | EOT | M | US | @ | m | g | t | 5 |
| | SHIFT | EOT | ] | US | ` | M | G | T | % |
| | CONTROL | EOT | CR | US | NUL | CR | BEL | $DC_4$ | NUL |
| $Y_5$ | NORMAL | ENQ | NAK | < | BS | n | f | r | 4 |
| | SHIFT | ENQ | NAK | < | BS | N | F | R | $ |
| | CONTROL | ENQ | NAK | NUL | BS | SO | ACK | $DC_2$ | NUL |
| $Y_6$ | NORMAL | ACK | SYN | > | [ | b | d | e | 3 |
| | SHIFT | ACK | SYN | > | { | B | D | E | # |
| | CONTROL | ACK | SYN | NUL | ESC | STX | EOT | ENQ | NUL |
| $Y_7$ | NORMAL | BEL | ETB | . | ] | v | s | w | 2 |
| | SHIFT | BEL | ETB | , | } | V | S | W | " |
| | CONTROL | BEL | ETB | NUL | GS | SYN | $DC_3$ | ETB | NUL |
| $Y_8$ | NORMAL | DC1 | CAN | SP | CR | c | a | q | 1 |
| | SHIFT | DC1 | CAN | SP | CR | C | A | Q | ! |
| | CONTROL | DC1 | CAN | SP | CR | ETX | SOH | DC1 | NUL |
| $Y_9$ | NORMAL | P | EM | . | LF | x | FF | HT | ^ |
| | SHIFT | @ | EM | . | LF | X | FF | HT | ~ |
| | CONTROL | DLE | EM | NUL | LF | CAN | FF | HT | RS |
| $Y_{10}$ | NORMAL | 0 | SUB | _ | DEL | z | ESC | VT | \ |
| | SHIFT | _ | SUB | _ | DEL | Z | ESC | VT | |
| | CONTROL | SI | SUB | US | DEL | SUB | ESC | VT | FS |

Code Assignment Chart - AY-5-2376 Keyboard Encoder




Schematic - KBD - 5 Keyboard and Encoder

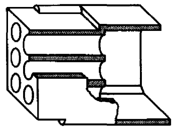



Key Configuration - KBD - 5 Keyboard

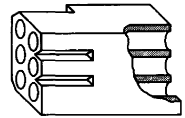
# Connector Reference Sheet

In order to avoid confusion in distinguishing between the various connectors supplied with our many kits, we are including this connector reference sheet with the kit instruction set. We have had a great many customers interchange the male and female connector shells when assembling their kits so we have clearly illustrated each connector along with its proper name and gender on this reference sheet. All are shown actual size.

Male Pin



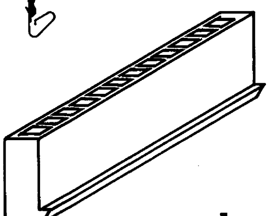
Molex Female Shell Connector



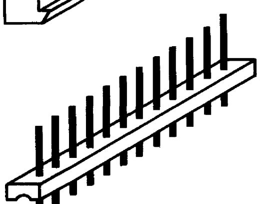
Molex Male Shell Connector

Female Pin

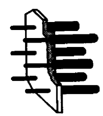
Pin for Harness Connector



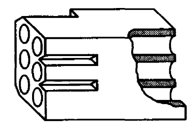
Harness Connector



Straight Pin Edge Connector



Molex Wafercon®



Molex Male Shell Connector

Male Solder Tail Pin
PC Type

Female Solder Tail Pin
PC Type

ROM

# Keyboard Encoder

## FEATURES

- One integrated circuit required for complete keyboard assembly
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- External control provided for output polarity selection
- External control provided for selection of odd or even parity
- Two key roll-over operation
- N-key lockout
- Programmable coding with a single mask change
- Self-contained oscillator circuit
- Externally controlled delay network provided to eliminate the effect of contact bounce
- Static charge protection on all input and output terminals
- Entire circuit protected by a layer of glass passivation

## DESCRIPTION

The General Instrument AY-5-2376 is a 2376 Bit Read Only Memory with all the logic necessary to encode single pole single throw keyboard closures into a usable 9-bit code. Data and strobe outputs are directly compatible with TTL/DTL or MOS logic arrays without the use of any special interface components.

The AY-5-2376 is fabricated with MTNS technology and contains 2942 P-channel enhancement mode transistors on a single monolithic chip.

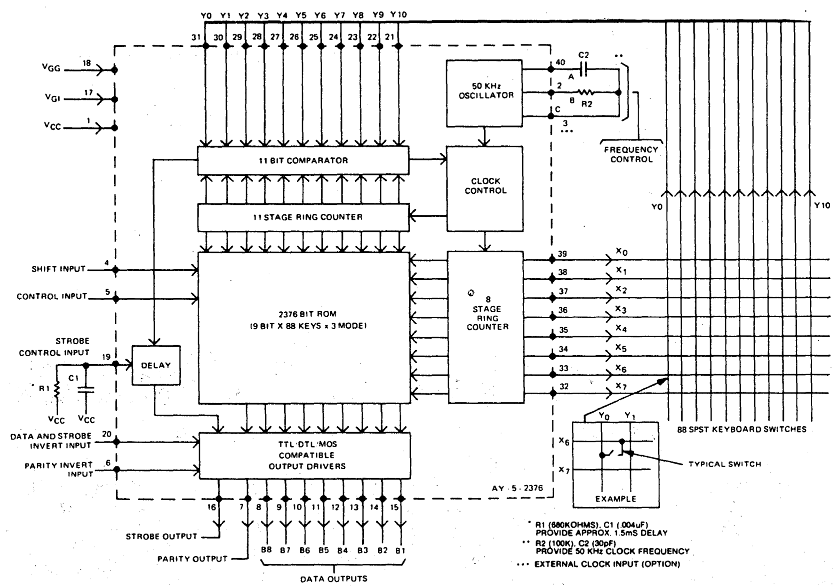
## PIN CONFIGURATION

40 LEAD DUAL IN LINE

Top View

| | | | | |
|---|---|---|---|---|
| $V_{CC}$ | 1 | 40 | Frequency Control A | |
| Frequency Control B | 2 | 39 | X0 | |
| Frequency Control C | 3 | 38 | X1 | |
| Shift Input | 4 | 37 | X2 | |
| Control Input | 5 | 36 | X3 | |
| Parity Invert Input | 6 | 35 | X4 | Keyboard Matrix Outputs |
| Parity Output | 7 | 34 | X5 | |
| Data Output B8 | 8 | 33 | X6 | |
| Data Output B7 | 9 | 32 | X7 | |
| Data Output B6 | 10 | 31 | Y0 | |
| Data Output B5 | 11 | 30 | Y1 | |
| Data Output B4 | 12 | 29 | Y2 | |
| Data Output B3 | 13 | 28 | Y3 | |
| Data Output B2 | 14 | 27 | Y4 | |
| Data Output B1 | 15 | 26 | Y5 | |
| Strobe Output | 16 | 25 | Y6 | Keyboard Matrix Inputs |
| $V_{GI}$ | 17 | 24 | Y7 | |
| $V_{GG}$ | 18 | 23 | Y8 | |
| Strobe Control Input | 19 | 22 | Y9 | |
| Data & Strobe Invert Input | 20 | 21 | Y10 | |

## BLOCK DIAGRAM



## OPERATION

The AY-5-2376 contains (see Block Diagram) a 2376-bit ROM, 8-stage and 11-stage ring counters, an 11-bit comparator, an oscillator circuit, an externally controllable delay network for eliminating the effect of contact bounce, and TTL/DTL/MOS compatible output drivers.

The ROM portion of the chip is a 264 by 9 bit memory arranged into three 88-word by 9-bit groups. The appropriate levels on the Shift and Control Inputs selects one of the three 88-word groups; the 88-individual word locations are addressed by the two ring counters. Thus, the ROM address is formed by combining the Shift and Control Inputs with the two ring counters.

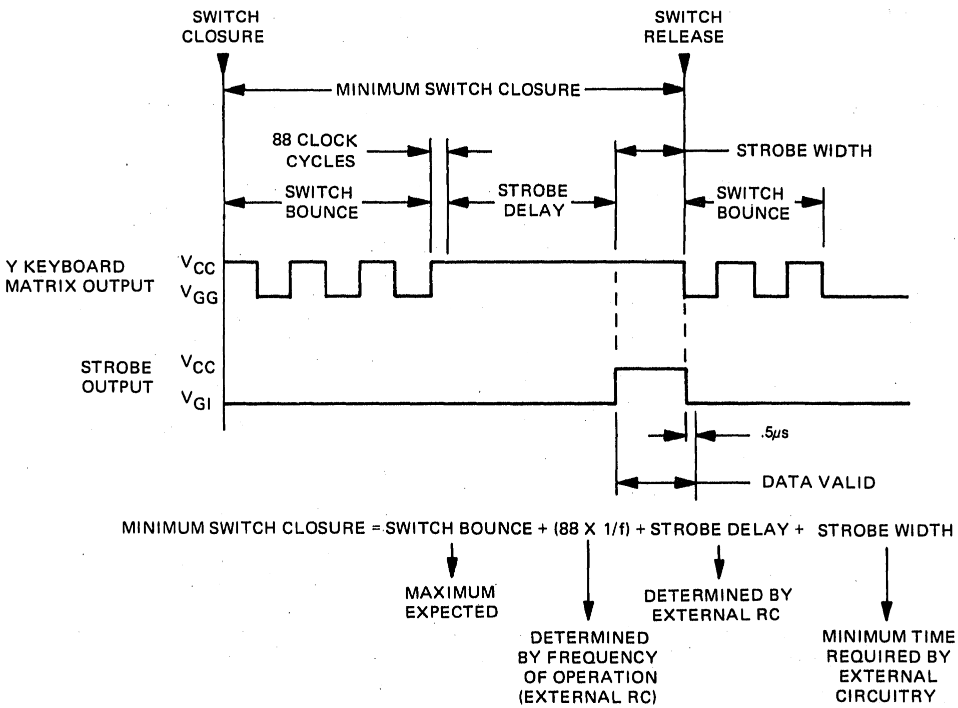
The external outputs of the 8-stage ring counter and the external inputs to the 11-bit comparator are wired to the keyboard to form an X-Y matrix with the 88-keyboard switches as the crosspoints. In the standby condition, when no key is depressed, the two ring counters are clocked and sequentially address the ROM; the absence of a Strobe Output indicates that the Data Outputs are 'not valid' at this time.

When a key is depressed, a single path is completed between one output of the 8-stage ring counter (X0 thru X7) and one input of the 11-bit comparator (Y0-Y10). After a number of clock cycles, a condition will occur where a level on the selected path to the comparator matches a level on the corresponding comparator input from the 11-stage ring counter. When this occurs, the comparator generates a signal to the clock control and 9, the Strobe Output (via the delay network). The clock control stops the clocks to the ring counters and the Data Outputs (B1-B9) stabilize with the selected 9-bit code, indicated by a 'valid' signal on the Strobe Output. The Data Outputs remain stable until the key is released.

As an added feature two inputs are provided for external polarity control of the Data Outputs. Parity Invert (pin 6) provides polarity control of the Parity Output (pin 7) while the Data and Strobe Invert Input (pin 20) provides for polarity control of Data Outputs B1 thru B8 (pins 8 thru 15) and the Strobe Output (pin 16).

ROM

### TIMING DIAGRAM



## ELECTRICAL CHARACTERISTICS

### Maximum Ratings

$V_{GI}$ and $V_{GG}$ (with respect to $V_{CC}$) . . . . . . . . −20V to +0.3V
Logic input voltages (with respect to $V_{CC}$) . . . −20V to +0.3V
Storage Temperature . . . . . . . . . . . . . −65°C to +150°C
Operating Temperature Range . . . . . . . . . 0°C to +70°C

*Exceeding these ratings could cause permanent damage. Functional operation of this device at these conditions is not implied—operating ranges are specified below.

### Standard Conditions (unless otherwise noted)

$V_{CC}$ = +5 Volts ± 0.5 Volts, ($V_{CC}$ = Substrate Voltage)
$V_{GG}$ = −12 Volts ± 1.0 Volts, $V_{GI}$ = GND. Operating Temperature ($T_A$) = 0°C to +70°C

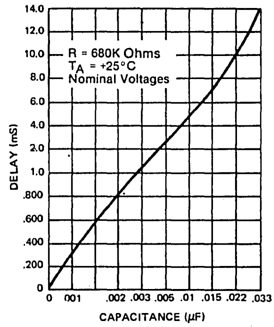
| Characteristics | Sym | Min | Typ** | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| **Clock Frequency** | f | 10 | 50 | 100 | KHz | See Block diagram footnote** for typical R - C values |
| **Data Input** | | | | | | |
| (Shift, Control, Parity invert, data & strobe invert). | | | | | | |
| Logic "0" Level | $V_{I0}$ | $V_{GG}$ | — | +0.8 | V | |
| Logic "1" Level | $V_{I1}$ | $V_{CC}$−1.5 | — | $V_{CC}$+0.3 | V | |
| | | | — | | | |
| Shift & Control Input Current | $I_{INS,C}$ | 15 | 36 | 60 | μA | $V_I$=+5V |
| | | 8 | 16 | 30 | μA | $V_I$= 0V |
| Data, Parity Invert Input Current | $I_{IND,P}$ | — | .01 | 1 | μA | $V_I$=−5V to +5V |
| **X Output ($X_0$-$X_7$)** | | | | | | |
| Logic "1" Output Current | $I_{XI}$ | — | 0 | — | μA | $V_{OUT} = V_{CC}$ |
| | | 80 | 150 | 400 | μA | $V_{OUT} = V_{CC}$ —1.3V |
| | | 140 | 300 | 800 | μA | $V_{OUT} = V_{CC}$ −2.0V |
| | | 250 | 700 | 1500 | μA | $V_{OUT} = V_{CC}$ −5V |
| | | 500 | 1500 | 3000 | μA | $V_{OUT} = V_{CC}$ — 10V |
| Logic "0" Output Current | $I_{XO}$ | 15 | 30 | 80 | μA | $V_{OUT} = V_{CC}$ |
| | | 13 | 27 | 65 | μA | $V_{OUT} = V_{CC}$ −1.3V |
| | | 12 | 25 | 60 | μA | $V_{OUT} = V_{CC}$ −2.0V |
| | | 5 | 10 | 40 | μA | $V_{OUT} = V_{CC}$ −5V |
| | | — | 1 | 20 | μA | $V_{OUT} = V_{CC}$ −10V |
| **Y Input ($Y_0$-$Y_{10}$)** | | | | | | |
| Trip Level | $V_Y$ | $V_{CC}$ −5 | $V_{CC}$ −3 | $V_{CC}$−2 | V | Y Input Going Positive |
| Hysteresis | $\Delta V_Y$ | .5 | .9 | 1.4 | V | Note 1 |
| | | | | | | Note 2 |
| Selected Y Input Current | $I_{YS}$ | 30 | 60 | 160 | μA | $V_{IN} = V_{CC}$ |
| | | 26 | 54 | 130 | μA | $V_{IN} = V_{CC}$ −1.3V |
| | | 24 | 50 | 120 | μA | $V_{IN} = V_{CC}$ −2.0V |
| | | 10 | 20 | 80 | μA | $V_{IN} = V_{CC}$ −5V |
| | | — | 2 | 20 | μA | $V_{IN} = V_{CC}$ −10V |
| Unselected Y Input Current | $I_{YU}$ | 15 | 30 | 80 | μA | $V_{IN} = V_{CC}$ |
| | | 13 | 27 | 65 | μA | $V_{IN} = V_{CC}$ −1.3V |
| | | 12 | 25 | 60 | μA | $V_{IN} = V_{CC}$ −2.0V |
| | | 5 | 10 | 40 | μA | $V_{IN} = V_{CC}$ −10V |
| Input Capacitance | $C_{IN}$ | — | 3 | 10 | pF | at 0V |
| **Switch Characteristics** | | | | | | |
| Minimum Switch Closure | — | — | — | — | — | See Timing Diagram |
| Contact Closure Resistance | $Z_{CC}$ | — | — | 300 | Ω | |
| | $Z_{CO}$ | $1\times10^7$ | — | — | Ω | |
| **Strobe Delay** | | | | | | |
| Trip Level (Pin 19) | $V_{SD}$ | $V_{CC}$−4 | $V_{CC}$−3 | $V_{CC}$−2 | V | |
| Hysteresis | $V_{SD}$ | .5 | .9 | 1.4 | V | See Note 1 |
| Quiescent Voltage (Pin 19) | | −3 | −5 | −8 | V | With 680K to $V_{SS}$ |
| **Data Output ($B_1$-$B_9$)** | | | | | | |
| Logic "0" | — | — | — | 0.4 | V | $I_{OL}$ = 1.6ma |
| Logic "1" | — | $V_{CC}$−1 | — | — | V | $I_{OH}$−100μa |
| **Power** | | | | | | |
| $I_{CC}$ | — | — | 5 | 10 | mA | $V_{CC}$ = +5V |
| $I_{GG}$ | — | — | 5 | 10 | mA | $V_{GG}$ = −12V |

**Typical values at +25°C and nominal voltages.

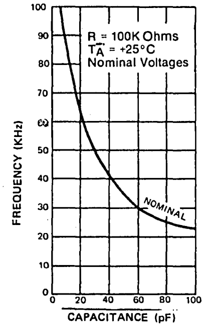
NOTE 1. Hysteresis is defined as the amount of return required to unlatch an input.
2. Guaranteed number of X & Y loads which may be applied to an X output = eleven.

ROM

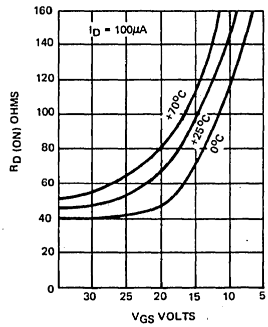
## TYPICAL CHARACTERISTIC CURVES



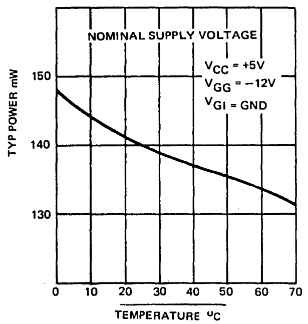

**STROBE DELAY C1**



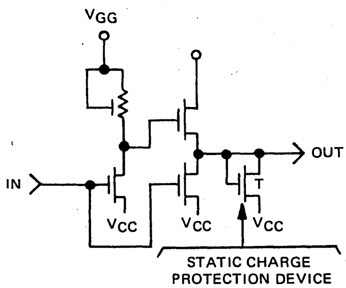

**OSCILLATOR FREQUENCY VS. C2**



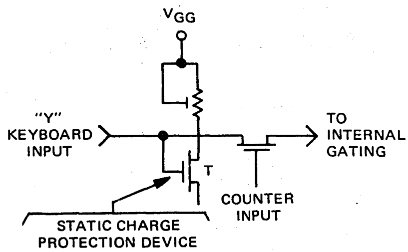

**TYPICAL OUTPUT ON RESISTANCE ($R_{DON}$) VS. GATE BIAS VOLTAGE ($V_{GS}$)**



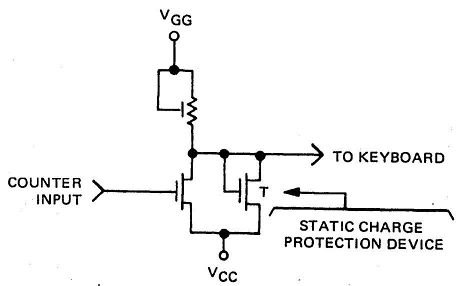

**TYPICAL POWER CONSUMPTION (mW) VS. TEMP (°C)**




**OUTPUT DRIVER**



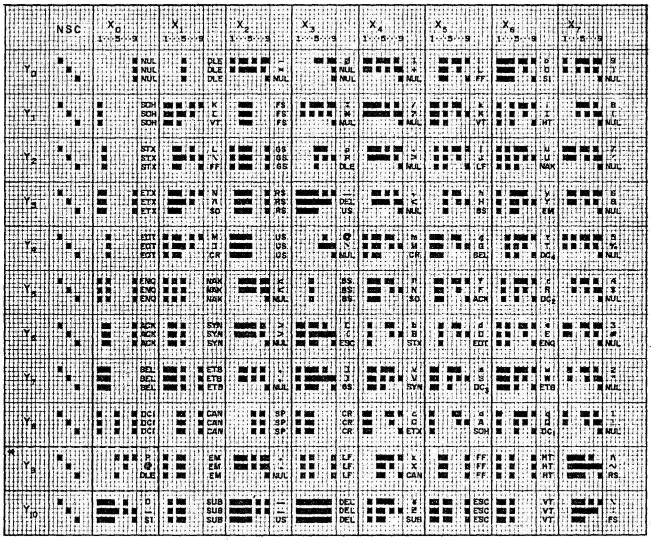

**"Y" INPUT STAGE FROM KEYBOARD**




**"X" OUTPUT STAGE TO KEYBOARD**

ROM

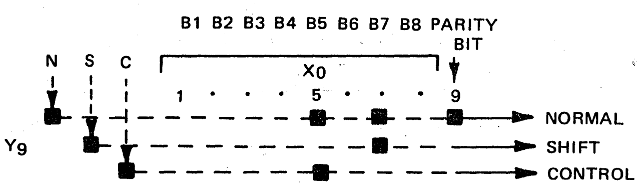
## STANDARD CODE ASSIGNMENT CHART



Illustrated using a Logic "O" on the Data and Strobe Invert Input (Pin 20) and the Parity Invert Input (Pin 6).

NOTE 1: This code is an 8 bit ASCII code (B1-B8). Output B9 is included as an odd parity bit operating on outputs B1-B7.

### *EXAMPLE




(CODE REPRESENTATIVE OF KEY DEPRESSION AT LOCATION $X_0$ — $Y_9$ AND PROPER MODE SELECTION)

N = NORMAL MODE
S = SHIFT MODE
C = CONTROL MODE
■ = OUTPUT LOGIC "1" (SEE DATA B1 — B8)
LOGIC "1" = +5V
LOGIC "0" = GND

## TRUTH TABLES

**DATA (B1-B8) INVERT TRUTH TABLE**

| DATA AND STROBE INVERT INPUT (PIN 20) | CODE ASSIGNMENT CHART | DATA OUTPUTS (B1-B8) |
|---|---|---|
| 1 | 1 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 0 | 0 | 0 |

**PARITY INVERT TRUTH TABLE**

| PARITY INVERT INPUT (PIN 6) | CODE ASSIGNMENT CHART | PARITY OUTPUT (PIN 7) |
|---|---|---|
| 1 | 1 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 0 | 0 | 0 |

**STROBE INVERT TRUTH TABLE**

| DATA AND STROBE INVERT INPUT (PIN 20) | INTERNAL STROBE | STROBE OUTPUT (PIN 16) |
|---|---|---|
| 1 | 1 | 0 |
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |

**MODE SELECTION**

$\overline{S}\ \overline{C} = N$
$S\ \overline{C} = S$
$\overline{S}\ C = C$
$S\ C = C$