THE ALPHA ELECTRONICS
INCIRCUIT IC TESTER

OPERATIONS AND ASSEMBLY MANUAL

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The parts supplied to you in this ALPHAkit are warrantied to be free from defects for a period of 90 days. The assembled version is warrantied to be free from defects in materials and labor for 90 days. Any parts or assembly that, in our opinion, have been misused or damaged will not be covered under this warranty.

FEATURES OF THE ALPHA INCIRCUIT IC TESTER

The Tester has a 12 key keyboard and a four digit alphanumeric display to allow manual entry and editing of test data and commands such as storing and loading test data to and from its internal nonvolatile memory, and optionally, to transfer test data to and from a computer via the RS232 serial channel. The display prompts the user to enter data as necessary and in addition, is used to display test results on a pin-by-pin, data expected, data read basis.

Since the Tester's 32K bytes of RAM are nonvolatile, backup batteries are not required for retention of test data. The Tester is therefore totally portable and test files may be generated on an external computer and downloaded to the Tester for field use. And, as the serial channel is two-way, files generated on the Tester may be exchanged with the computer for modification or future use.

IC's are tested dynamically, that is the inputs are cycled high and low per the test routine, up to forty times. This allows thorough testing of the more difficult type parts such as counters, flip-flops and registered devices.

HOW THE TESTER TESTS

Testing an IC out of circuit is a straight forward operation. Using test information generated from a data sheet, the tester simply writes the data to the device and reads back the results for comparison. Since nothing else is connected to the IC under test, no compensation need be made for input pins being connected to an output of the same or other device or an input pin being tied to ground or Vcc.

To test IC's incircuit, the Tester addresses these major issues in the following manner: The output drivers can be floated (hi-impedance state) and have enough source and sink drive to pull an input high or low (very briefly) even if connected to an output, and the test routine can be readily modified to ignore pins which are tied to ground or Vcc.

Let's start with some background on the way data is used by the Tester to test IC's. There are 24 slots in the Tester's enter buffer with 2 bytes per slot per group. The first byte in each slot determines the function of the pin, i.e., In, Out, Indeterminate or Ignore. The second byte is a double hex digit with a total of 8 bits. These digits are hex representations of 256 possible binary bytes. There are 5 groups resulting in 40 bits of available test data. There are 2 X 24 X 5 = 240 + 16 bytes for part number and number of pins equaling 256 bytes in the enter buffer and also stored in the Tester's memory when a test routine is saved there. There are 512 bytes in a test file sent to or received from a computer (X 2 because each hex digit is converted to ASCII for sending and receiving).

Now since each group has storage for the pin function, the pin function may be changed for each group. This would be done for a transceiver (i.e., a 74LS245) because the input pins also serve as output pins. Each bit of test data represents one test cycle. One cycle consists of sending one bit to each of eight drivers in each of three NE590's and NE591's. Since the 591 is a pullup to 5 volts a 1 (on) to it will put a high on the associated pin and a 1 (on) to the 590, being a pulldown to ground, will put a low on its attached pin. If a pin is to be ignored, a zero (off) goes to both drivers, so the pin is tri-stated. The appropriate test levels are written to the output drivers one pin at a time, starting with the lowest pin, and the drivers latch these levels. The levels on all pins are read in one byte at a time starting with the lower eight pins. The cycle is repeated seven more times and all of the above is repeated for each of a possible five test groups.

Next the test results are compared bit by bit for all active pins, including the inputs, with the expected results information entered in the test file. We check the information from the IC's inputs as well as outputs, since it is possible that an input pin may be shorted by a solder bridge or fault on the board. The results of the test are then shown in the display.

The drivers in the 590's and 591's are Darlington transistors capable of 250 milliamps of current source or sink. All of the active inputs are connected to a TTL level output somewhere in the circuit, so these high current drivers are necessary. Both pullup and pulldown outputs are off where we wish to ignore or read a pin (the pin is an output or is connected to an output which is controlled by an output that is integral to the test results, or is tied to Vcc or ground) or one of the outputs is on and the other off to apply the test level to an input. Each pin on the test clip is connected to three different IC's on the Tester's driver board. Each test clip pin may therefore be used to pull the device-under-test's (DUT's) pins high or low and to allow the pin to float when we wish to read or ignore the pin.

The Tester is not limited to incircuit testing of IC's, but will test IC's just as well out of circuit. The Tester can also be used as a logic tester to test as many as twenty four points in a digital system if the test clip is replaced by individual test hook type clips. Some would be used as outputs to stimulate the circuit and others as inputs to read the results.

TECHNICAL DESCRIPTION

Zilog's Z80 workhorse is used as the microprocessor. The Z80 requires little external support (in this case memory, a 5 volt regulated power supply, a reset capacitor and resistor and a clock) and its 8 bit data bus is totally adequate for the job. The processor's 2Mhz clock is generated by an integrated crystal clock oscillator. A crystal clock is required for precise timing of the serial communications channel and 2Mhz is more than fast enough for other tasks.

Since a major feature of the Tester is its ability to store many test routines, a large amount of nonvolatile storage is needed. The DS1230 32K byte Nonvolatile Static RAM provides this storage. The lower 4K bytes of it contain the operating program for the Z80

Microprocessors have been known, through no fault of there own, to go off into never-never-land, writing all kinds of trash in RAM behind them. While this is not likely to happen, some provision must be made to prevent its occurrence from corrupting the operating program. The program area must be write protected. Part of one of three custom (CMOS Gate Arrays) IC's, the 75498, is connected in the write enable line to the RAM. It decodes address lines A12 through A14, and disables the processor's write enable signal whenever all three of these address lines are low, thus preventing corruption of the critical operating program. The balance of the 75498 decodes the input and output strobes for the driver board and display. The next custom IC, the 75500, is the input/output port for the keyboard and the display. It latches the appropriate keyboard row signals and reads the column signals of the keyboard, and latches the digit address lines for the display. The last custom IC, the 75499, is used in the serial I/O channel. It decodes the port strobes, latches the serial out data and serial in busy signals and reads the serial in data and serial out busy lines. The RS232 driver/receiver interface IC, the MAX233 provides level conversion between the + and - 10 volt RS232 lines and the TTL levels of the 75499, and has an internal converter to provide the + and - 10 volt levels from the main 5 volt power supply

The keyboard and display provide the human interface. The Tester has many prompts to simplify this interface so we use a DL1414 Intelligent Alphanumeric Display. It contains built in storage, decoders and drivers for its four red 16-segment LED digits. Twelve tactile feedback type keyswitches are used in the keyboard. They are electrically arranged in two columns of five rows and are scanned by the 75500 IC.

There are nine IC's on the driver board. Three each of a NE590, NE591 and 74LS373. The 590's and 591's are 8 bit addresseable latches with drivers that have either open collectors (590) or open emitters (591). The 590's outputs pull to ground and the 591's pull to Vcc. We connect these drivers to the pins of the IC being tested through J106 by way of the test cable and clip. As mentioned earlier the logic level on these pins may be high, low or float. The 373's are wired as three-state input ports and are used to read the DUT's pin levels during testing. J105 has pins for Vcc and ground. The ground pin, through a wire in the test cable, is terminated with a test hook clip and is connected to ground on the circuit board being tested. The Vcc pin may be terminated in the same manner and used to supply power to an IC for out of circuit testing. The Tester's power supply will not supply enough current for any external circuitry, so the system being tested must have its own power supply.

ASSEMBLING THE TESTER

The boards have been designed for mounting in the case supplied with the kit or they may be used without a case.

( ) Whether using a case or not the sockets are installed on the component side of the boards as are all of the other components (except the keyswitches and display, which are installed later), in no particular order. When installing capacitors C111, C114 and C117 bend their ground leads up and solder them to pin 8 of U108, U111 and U114 respectively. A square pad on the PC boards indicates the position for pin one of all IC's. Be sure to check proper orientation of the electrolytic capacitors, the diode, the clock module (pin 1 is indicated by a black dot) and the voltage regulator. The voltage regulator is installed so that its metal tab will be against the large foil heatsink area of the board when it is bent down to the board. Secure it with the #6-32 screw and nut.

( ) Next mount one ten, two 20 and one 26 pin male header strips on the boards.

( ) Cut two 3" lengths off the end of the insulated wire from the power transformer's cord and connect the power (toggle) and reset (pushbutton) switches to the board with them. Connect the wire to the center and one of the other terminals of the power switch and to two of the pads on the board. The remaining terminal of the power switch and one of the commoned pads on the board are not used.

( ) Run the leads of a 9.5VDC or a 12VAC 1 Amp wall mounted transformer through the hole in the case cover and connect them to the board. We may have supplied either an AC or DC supply with your kit. If the supply is DC it will be labeled P/No. 251539-01/02, and the '-' lead from it will have '- - - - - - - - -----------' printed on it in white ink. Connect this lead to the foil pad of J103 which is connected to a pad for the fuse and the other lead to the pad of J103 that is connected to a pad for the power switch. If the supply is AC the leads may be connected in any order. Do not install any IC's.

( ) Connect the driver board to the main board with the twenty conductor flat ribbon cable terminated on each end with a twenty pin female header connector. The cable should run away from the edge of the boards.

CAUTION!!!!
At this point we have an opportunity to wipe out the operating program in the RAM. If there is a solder short on the board at the right (wrong) place, the write protect function of the 75498 will be defeated, and or the write enable pin on the RAM may be held permanently low (write state) allowing just about anything and everything to be written where it will do the most damage.

( ) To prevent this disaster, check with an ohmmeter to be sure there is no connection between ground, Vcc or any trace on the board, and the following pins at the sockets for the 75498, RAM and Z80. The 75498 pins 1, 2, 3, 4 and 19, the RAM pins 20, 27 and all of the address pins and the Z80 pins 20, 21, and 22.

( ) This done we may safely proceed with applying power to the board. Measure the Vcc source, the pin on the voltage regulator near the '+' symbol on the board. There should be 5 volts here + or - .25 volt.

( ) Assuming that this is OK, check the output of the clock module (pin 3) for a 2Mhz square wave if you have a scope, or for a fast pulse train if using a logic probe. If there is, we have an indication that the board may have been assembled correctly, and it should be safe to proceed. Remove power from the board and allow a minute for the filter capacitors to discharge.

There are two possible locations for mounting the display. The twelve pin pad group nearest the top of the keyboard is for mounting the display on the solder side of the board. This is done when the Tester will be installed in a case. The keyswitches will also be mounted on this side of the board in this case. If the Tester will be used sans case, mount the keyswitches and display on the component side of the board. The holes nearest the voltage regulator are then used for the display.

( ) Because of the restricted clearance in the case a socket is not used for the display. Each display has been 100% tested by us and if it is soldered in carefully, it will not need a socket. Install and solder the 12 pin display on the solder side of the board and in the 12 holes nearest the top row of switches. The display's pin one is marked with a white stripe. Next to this stripe you will see a letter, such as 'A', 'B' or 'C' and 'DL1414'. When properly installed this edge will be next to the switches.

( ) If you are using a case install the keyswitches on the solder side of the board. Orient each of the switches so that the flat sides on them are parallel to the shorter edges of the board. The colors of the keyswitches are not important as we have provided caps for them which are of the proper colors. Turn the board over and solder the four pins of each switch from the component side.

( ) Properly orient the flat edge of the caps to the flat edge of each switch and snap them on.

( ) The labels on the polyester sheet supplied with your kit are positioned in the proper locations for each switch and it may be used as a guide for installing the colored key caps. The '0', '1', '2', '3', '4', '6', '7' and '8' are white, the 'ENTER' green, the '^' (SHIFT) yellow, the '5' red and the '9' blue. With scissors or a straight edge and sharp artist's knife cut the 12 key labels from the label sheet. Cut inside the black lines which surround each label. Remove the backing from the labels one at a time and apply them to the appropriate keys.

see Errata page

( ) Being careful to observe proper procedures to avoid static damage to the MOS (Z80) and CMOS (RAM, MAX233, 75498, 75499 and 75500) IC's, install all IC's in their sockets properly oriented. There is a square foil pad on the board at pin 1 of all IC's and the parts layout also shows the location of this key pin. When you're positive that all parts are installed correctly, in the correct place, no pins bent under any of the IC's (especially the RAM and the 75498) and so on, you are ready to test the assembly.

* ( ) Connect a jumper between pin 3 and 4 of J101 (Comm Channel jack on the main board) and another between pin 5 and 6 of J101. Apply power again while holding down any keyswitch other than the 'Shift' key. As there is a power on self test (POST) built into the RAM, and since applying power with any key depressed other than the 'Shift' key activates the self test, you should see, in the display, 'POWER ON SELF TEST' (indicating that most every thing is working) '0000 **** . . .' (indicating that the display is OK) 'MEMORY TESTS GOOD' (indicating that all memory locations from 4096 to 32768 are good) or 'MEMORY HAS SOME BAD BYTES' (if there is a memory problem) 'DRIVER BOARD TESTS OK' or 'PROBLEM WITH DRIVER BOARD' (depending on the condition of the driver board) 'COMM CHANNEL TESTS OK' or 'ERROR ON COMM CHANNEL' (depending on condition of the communications channel).

( ) When the last message is displayed, press 'Shift' ('^') then 'CLR'. This will initialize the directory for future storage of test routines. This should only be done before any routines are stored or if you wish to clear all routines from the memory.

If you have run the 'POST' after entering test routines that you do not want to erase, press any other key (except 'Shift') to exit the 'POST' routine.

It may be of interest to know that should, for some reason, the non write-protected RAM become scrambled (especially the directory area), strange things will happen. For example, you may be able to 'Load' a test routine by number which you have never stored. Or you may 'Load' a routine which you have stored and find that it bears no resemblance to what you 'Store'd. This will probably never happen, but in case it does, enter the 'POST' and initialize the directory as described above.

The following IC's and parts have been tested by us before shipment to you: the Z80, AE1230-104, 75498, 75499, 75500, DL1414 and the voltage regulator. All other IC's and parts were tested by their respective manufacturers prior to distribution. It is therefore highly unlikely that you have received any bad parts with your kit. If you have difficulty getting it to work properly, we suggest that you go over all of your assembly work to determine what, if any, errors you may have made. If all else fails, contact us for technical assistance. We do not repair assembled kits, however we will probably be able to resolve any problems you may have. All parts (except those damaged by misuse or mishandling) are guaranteed for 90 days.

( ) Remove the jumpers from J101 and press the reset button. "COMMAND?" should scroll repeatedly across the display. If so the Tester is ready to test, load, store, send, etc. Turn the power off and unplug the transformer.

( ) Mount the driver board on the bottom of the case with the 26 pin header near the wide slot on the back edge. Secure it with two #4-1/4" self-tapping screws. With the two #6-1/4" self-tapping screws attach the two white self-tapping bosses to the solder side of the main board. Use the two holes on the shorter edge of the board nearest the switches and voltage regulator. You will have to orient the one near the 'Shift' key to clear the key. Remove the protective covers from the tape on the bottom of the bosses.

( ) Lay the top of the case on its face. Place the main board, switch side down, into the top cover, but do not press down on the bosses. Align the board so that you can install the remaining two #4-1/4" self-tapping screws in the two bosses, which are part of the case, on the other edge of the board. Install but don't tighten, these screws. Turn the cover over and align the board so that the keyswitches clear the label on all four sides. This done, press on the self-tapping bosses to secure them to the cover. Double check the keyswitch clearance. Turn the case over and tighten the two #4-1/4" and #6-1/4" screws.

( ) If you are going to use the serial port for sending and receiving files with a computer, use the 10 conductor flat ribbon cable with a 10 pin female header connector on one end and a DB9 chassis mount connector on the other. Mount the DB9 connector on the back of the case bottom with the screws and nuts provided. Connect the 10 pin female header to the main board with the cable running away from the edge of the board.

( ) On the back of the case top mount the power switch with the unused terminal toward the top of the case, and the reset switch so that its terminals clear the fuse

( ) Finally, put the two case halves together and secure with the screws provided

( ) Using a maximum of three feet of 26 conductor flat ribbon cable, make the test clip cable. Terminate one end with a 26 pin female header connector. On the other end of the ribbon cable, separate out the 25th and 26th wires. Terminate the 25th one (+5 volts) with a red test hook clip and the 26th (ground) with a black test hook clip. Terminate the remaining 24 wires with two 12 pin single row female header connectors. Space the two single row connectors 1 3/4" apart. The one at the end of the cable will terminate the odd numbered wires and the other, the even ones.

( ) Obtain a 16 pin, a 20 pin and a 24 pin IC test clip. As these clips are quite expensive, we will use the 16 pin clip to test 14 and 16 pin IC's and the 20 pin clip for 18 and 20 pin IC's. When installing the test clip on the cable, orient the clip so that the connector on the end of the cable connects to the side of the test clip with pin 1 on it. When using a clip with less than twenty four pins, align the connectors so that the pins on the right end of the clip (the end farthest from pin 1) are even with the right end of the connectors.

( ) Depending on the connector and connections on your computer's serial card, prepare an appropriate cable to connect between the DB9 and your computer.

As there are many variations to RS232 serial ports, you will have to determine which pins are needed. The TXD and RXD pins on the Tester's main board send and receive serial data (1200 baud, no parity, 8 data bits and 2 stop bits) respectively CTS is the TXD handshake signal and RTS is the same for RXD. The Tester requires no other signals to work properly, however your computer's serial port might. On the Tandy 1000 and most PC compatible ports, connecting DSR, CD, DTR and RI together will work. It is not to be implied from the above that a PC compatible is the only computer which can be used with the Tester In fact, it will work with the Radio Shack Model III, 4, Color Computer, Commodore and Apple computers, to name only a few.

( ) Plug in the test clip cable and the power transformer and turn the power switch on

GENERATING AND ENTERING TEST ROUTINES

The following information is what you will need to convert data sheet specifications to test data for inputting to the Tester. It will be used whether entry is by external computer or via the Tester's keyboard.

The first example illustrates the process for a 7404. From the 7404 data sheet we obtain the pin numbers for the inputs, outputs, Vcc and ground, and the functional description of, or truth table for, the part.

From the data sheet we see that it is a hex inverter. Make a copy of the master template. Fill in the part number, number of pins, group number (make a template for each test group if you need more than one group) and pin numbers. You may also sketch the symbols for the part from the data sheet in the frame for the IC. As data is sent to the drivers least significant bit first, start on the right and work to the left. If we put a 1 into an inverter we should get a 0 out of it. Put a 1 next to pin 1. Put a 0 next to pin 2. Repeat with the remaining 5 inverters. Put an X next to pins 7 and 14 to indicate that they will be ignored. We have created the information for the first test cycle. Next put a 0 at each input and a 1 at each output. Since the minimum number of cycles is 8 (one byte has 8 bits of course) we will repeat the above four times Now convert the 8 bits at each pin to 2 hex digits. A binary to hex conversion table is shown.

This is the test data for a 7404, and with the In, Out and Ignore function codes entered before it on the keyboard of the Tester, is all the information needed to test this part. As with this or any other part, the data on the input pins is sent to the IC under test to exercise it and the data entered for the output pins is the information which will be used for comparison with the data read back during testing. This information along with part number and number of pins is all that is stored in the Tester's memory. There is no need for more than one group to completely test a 7404.

Testing a 7404

Group 1

		Pin	7404	Pin		
01010101=55	I	1		14	X	
10101010=AA	O	2		13	01010101=55	I
01010101=55	I	3		12	10101010=AA	O
10101010=AA	O	4		11	01010101=55	I
01010101=55	I	5		10	10101010=AA	O
10101010=AA	O	6		9	01010101=55	I
X		7		8	10101010=AA	O

The following is a step-by-step description of what is entered on the Tester's keys, and the prompts shown in the display:

The Commands on the Tester are self prompting to ease entry of test data. Press the keys deliberately, watching for the response in the display.

```
KEY(S) PRESSED         SHOWN IN DISPLAY

                       COMMAND?
NEW                    PART NO.?
0                      0
4                      04
ENTER                  NO. OF PINS?
1                      1
4                      14
ENTER                  TYPE-DATA? PN01
I                      I
5                      I5
5                      I55
ENTER                  TYPE-DATA? PN02
O                      O
^                      ^ O
A                        OA
^                      ^ OA
A                       OAA
ENTER                  TYPE-DATA? PN03
I55                    I55
ENTER                  TYPE-DATA? PN04
OAA                    OAA
ENTER                  TYPE-DATA? PN05
I55                    I55
ENTER                  TYPE-DATA? PN06
OAA                    OAA
ENTER                  TYPE-DATA? PN07
IGNORE                 X
ENTER                  TYPE-DATA? PN08
OAA                    OAA
ENTER                  TYPE-DATA? PN09
I55                    I55
ENTER                  TYPE-DATA? PN10
OAA                    OAA
ENTER                  TYPE-DATA? PN11
I55                    I55
ENTER                  TYPE-DATA? PN12
OAA                    OAA
ENTER                  TYPE-DATA? PN13
I55                    I55
ENTER                  TYPE-DATA? PN14
IGNORE                 X
                       MORE OR END?
END (Unless we need more groups)
                       COMMAND?
```

(The Test clip would be connected to the 7404 at this point)

```
TEST                   TESTING
                       IC TESTS GOOD (OR ERROR PIN?? GRP? EXP/RD ????)
```

Of course, we must determine the correct data for an IC incircuit. We do this by modifying the data sheet information for the specific incircuit configuration. For example, pins of an IC may be tied to Vcc or ground, so we define the pin as ignore. If an input of an IC is connected to one of its outputs, we ignore that input since its data will be supplied by the output it's connected to. Here's an example of this:

Group 1

			7404			
01010101=55	I	1		14	X	
10101010=AA	O	2		13	X	
X		3		12	00000000=00	O
01010101=55	O	4		11	01010101=55	I
X		5		10	10101010=AA	O
10101010=AA	O	6		9	01010101=55	I
X		7		8	10101010=AA	O

We can illustrate the need for more than one test group in the following manner.

The data for testing a 74LS245 Transceiver in send mode is:

Group 1

			74LS245			
11111111=FF	I	1	S/*R	20	X	
01010101=55	I	2	*CE	19	00000000=00	I
01010101=55	I	3		18	01010101=55	O
01010101=55	I	4		17	01010101=55	O
01010101=55	I	5		16	01010101=55	O
01010101=55	I	6		15	01010101=55	O
01010101=55	I	7		14	01010101=55	O
01010101=55	I	8		13	01010101=55	O
01010101=55	I	9		12	01010101=55	O
X		10		11	01010101=55	O

The data for testing a 74LS245 Transceiver in receive mode is:

Group 2

			74LS245			
00000000=00	I	1	S/*R	20	X	
01010101=55	O	2	*CE	19	00000000=00	I
01010101=55	O	3		18	01010101=55	I
01010101=55	O	4		17	01010101=55	I
01010101=55	O	5		16	01010101=55	I
01010101=55	O	6		15	01010101=55	I
01010101=55	O	7		14	01010101=55	I
01010101=55	O	8		13	01010101=55	I
01010101=55	O	9		12	01010101=55	I
X		10		11	01010101=55	I

A registered (latched) IC requires toggling its enable pin as follows.

The data for testing a 74LS373 Octal Latch is:

Group 1

			74LS373			
00000000=00	I	1	*OE	20	X	
10010001=91	O	2		19	10010001=91	O
10011001=99	I	3		18	10011001=99	I
10011001=99	I	4		17	10011001=99	I
10010001=91	O	5		16	10010001=91	O
10010001=91	O	6		15	10010001=91	O
10011001=99	I	7		14	10011001=99	I
10011001=99	I	8		13	10011001=99	I
10010001=91	O	9		12	10010001=91	O
X		10	EN	11	10110011=B3	I

A clocked IC requires the toggling of its clock pin and illustrates the reason for having the Indeterminate function. Since a clocked device with no means of setting and clearing its outputs will have an indeterminate state before it is clocked, we will enter it as indeterminate, 'D'. The first state of a pin which is defined as indeterminate will be cleared to zero. The remaining 7 states of the first group will be processed normally. If more than one test group is needed, the first state of each additional group will not be indeterminate and should be defined as Output. You will notice that we have setup the data for the first cycle so as to have a '0' on all outputs and to be prepared for the positive-going edge of the clock on pin 11 during the second cycle. Note that indeterminate applies only to outputs.

The data for testing a 74LS374 Octal D Flip-flop is:

Group 1

00000000=00	I	1	· *OE	20	X	
10011000=98	D	2		19	10011000=98	D
11001100=CC	I	3		18	11001100=CC	I
11001100=CC	I	4		17	11001100=CC	I
10011000=98	D	5	74LS374	16	10011000=98	D
10011000=98	D	6		15	10011000=98	D
11001100=CC	I	7		14	11001100=CC	I
11001100=CC	I	8		13	11001100=CC	I
10011000=98	D	9		12	10011000=98	D
X		10	CLK	11	10101010=AA	I

An IC with many inputs or outputs or one with many possible states illustrates another reason for more than one test group. A 74154 has 17 possible output states if we test its enable pins.

The data for testing a 74154 1-of-16 Decoder is:

Group 1

11110111=F7	O	1	·	24	X	
11101111=EF	O	2		23	01010111=57	I
11011111=DF	O	3		22	01100111=67	I
10111111=BF	O	4		21	10000111=87	I
01111111=7F	O	5		20	00000111=07	I
11111111=FF	O	6	74154	19	00000011=03	I
11111111=FF	O	7		18	00000101=05	I
11111111=FF	O	8		17	11111111=FF	O
11111111=FF	O	9		16	11111111=FF	O
11111111=FF	O	10		15	11111111=FF	O
11111111=FF	O	11		14	11111111=FF	O
X		12		13	11111111=FF	O

Group 2

11111111=FF	O	1	·	24	X	
11111111=FF	O	2		23	01010101=55	I
11111111=FF	O	3		22	01100110=66	I
11111111=FF	O	4		21	10000111=87	I
11111111=FF	O	5		20	11111000=F8	I
11111110=FE	O	6	74154	19	00000000=00	I
11111101=FD	O	7		18	00000000=00	I
11111011=FB	O	8		17	11111111=FF	O
11110111=F7	O	9		16	11111111=FF	O
11101111=EF	O	10		15	11111111=FF	O
11011111=DF	O	11		14	01111111=7F	O
X		12		13	10111111=BF	O

Group 3

11111111=FF	O	1	·	24	X	
11111111=FF	O	2		23	11111101=FD	I
11111111=FF	O	3		22	11111110=FE	I
11111111=FF	O	4		21	11111111=FF	I
11111111=FF	O	5		20	11111111=FF	I
11111111=FF	O	6	74154	19	11111000=F8	I
11111111=FF	O	7		18	11111000=F8	I
11111111=FF	O	8		17	11111011=FB	O
11111111=FF	O	9		16	11111101=FD	O
11111111=FF	O	10		15	11111110=FE	O
11111111=FF	O	11		14	11111111=FF	O
X		12		13	11111111=FF	O

The data for testing a 74LS157 Data Selector/Multiplexer is:

Group 1

00000000=00	I	1	·	16	X	
10101010=AA	I	2		15	00000000=00	I
X		3		14	10101010=AA	I
10101010=AA	O	4	74LS157	13	X	
10101010=AA	I	5		12	10101010=AA	O
X		6		11	10101010=AA	I
10101010=AA	O	7		10	X	
X		8		9	10101010=AA	O

Group 2

11111111=FF	I	1	74LS157	16	X	
X		2		15	00000000=00	I
01010101=55	I	3		14	X	
01010101=55	O	4		13	01010101=55	I
X		5		12	01010101=55	O
01010101=55	I	6		11	X	
01010101=55	O	7		10	01010101=55	I
X		8		9	01010101=55	O

A 74LS158 is tested the same way, except the data at the outputs will be inverted.

The data for testing a 74LS279 Quad R-S Latch is:

Group 1

11010110=D6	I	1	74LS279	16	X	
01011010=5A	I	2		15	11001100=CC	I
10011100=9C	I	3		14	10101010=AA	I
11100111=E7	O	4		13	00110011=33	O
10101010=AA	I	5		12	01011010=5A	I
11001100=CC	I	6		11	10011100=9C	I
00110011=33	O	7		10	11010110=D6	I
X		8		9	11100111=E7	O

As can be seen from the above examples, generating test data is simply a matter of determining the functions of the pins and setting up the correct sequence of 1's and 0's for the input pins and the expected levels for the output pins of a good IC. To generate these 1's and 0's requires that we understand how an IC works. In other words, what happens at the outputs if we do such and so to the inputs. This information is clearly stated in the part's data sheet. All that is left is to modify the data to suit the incircuit connections of the IC to be tested.

In addition we have included generic test data for a number of functional logic blocks (i.e. D flip-flop, gate etc.) at the end of the manual. Select the appropriate block and apply the data to the IC you want to test. Usually this only requires assigning the data to the proper pin numbers on the template and adding the pins you wish to ignore depending on how the device is used in the circuit you are testing.

ENTERING TEST DATA ON THE TESTER'S KEYBOARD AND TESTING A PART

First a few words of caution. Never connect the test clip to an IC which has power on it unless the Tester is on and 'COMMAND?' is scrolling in the display, and conversely, never shut the Tester off when the clip is connected to a powered IC. Connect the black test hook clip to a ground on the board near the IC's to be tested. The test drivers are rated at 7 volts maximum, so be careful what IC's you connect to. A powered 1488 has + and - 12 volts on it and might damage the drivers. This all stands to reason as the unit is designed to test only TTL and TTL compatible CMOS and MOS IC's, and with the exception of parts with open collector outputs, these voltages will normally be 5 Volts. If you inadvertently connect the clip to an IC wrong, or if you have entered the test data incorrectly the display will probably dim. Disconnect the clip immediately and turn off the power switch on the back of the Tester.

The following Commands will work when 'COMMAND?' is scrolling in the display: 'LOAD', 'STORE', 'SEND', 'RECV', 'NEW', 'TEST', 'EDIT' and 'CLR' (CLEAR). The '^' (SHIFT) key is always used for the upper legend on the keys, i.e., ^6 is a 'D', ^5 is 'CLR' and ^1 is 'INDET' (Indeterminate). The '^' key is a toggle. On first pressing it a '^' will appear in the left most display digit, and will disappear when '^' is pressed again or when any other key is pressed, and it must be pressed each time you want to use the shifted key function.

As a rule, you should turn on the tester and the circuit to be tested, connect the black ground test hook clip and then connect the test clip to the IC to be tested. If the test clip has more pins than the IC, align the right end (end farthest from pin one) of the clip with the right end of the IC

( ) Using 'NEW' to enter a new test routine, is as follows: With 'COMMAND?' showing, press 'NEW'. The enter buffer is cleared of any previous test data. (This also occurs at power up and when the reset button is pressed.)

( ) 'PART NO.?' will appear. You may enter between one and eight numbers or letters. (This gives the ability to have an IC number as high as 99,999,999 to allow for entering IC's well beyond the new TI '11000' series). Press 'ENTER'.

( ) 'NO. OF PINS?' will appear. You may enter any even number(s) between 4 and 24 inclusive. Press 'ENTER'.

( ) 'TYPE-DATA? PN01' will appear. Enter the function of pin 1, 'IN', 'OUT', 'INDET' or 'IGNORE', and then the test byte in two Hex digits. I.e., 'I55', 'OAA', 'X' (no data necessary), or 'D98'. The appropriate characters will appear in the display. When you have entered the data for all the pins or all the pins you want to enter data for press 'END'.

( ) The display will ask 'MORE OR END'. Press 'MORE' unless you wish to enter data for another test group (there are five groups possible), in which case press 'END' again.

( ) While we're at this point a description of the first use of the 'EDIT' key is in order. Use it to back up one pin if you make an error after entering all three (or one if 'IGNORE') of the test data characters. Each time you press 'EDIT' you will back up one pin. If you press 'END', this only works immediately after, when 'MORE OR END' is showing.

( ) Press the 'TEST' key when all data is entered. The results, 'IC TESTS GOOD' or 'ERROR PN?? GRP? EXP/RD ????' will scroll across the display for each pin in error. 'EXP/RD ????' means 'Expected/Read (data expected/data read in)' for each pin in each group.

( ) 'CLEAR' will work at any time the Tester is expecting a keyboard entry, and is the same as pressing the reset button.

The 'LOAD' and 'STORE' commands refer to the Tester's internal memory. There are 105 directory slots for storage of test routines. The routines are stored in memory using the part number entered with them.

( ) If you wish to save the entered test data, press 'STORE' and the data will be stored in the nonvolatile memory for future use under the part number previously entered with it.

( ) If you wish to load a test routine, press 'LOAD' and then the part number. If the part was found 'CLEAR OR ENTER' will appear. Use 'CLEAR' to erase this entry from memory if you no longer need it, or 'ENTER' to leave the data in the test buffer for testing or transfer to the external computer with 'SEND'.

( ) Use 'RECV' to download a test file from the external computer. It may then be stored with 'STORE'.

( ) Another use of the 'EDIT' key is for modifying data already entered for a part. Press 'EDIT' ('^ 9') while 'COMMAND?' is displayed and after new test data has been entered or data has been 'Load'ed or 'Recv'd. The same messages will be displayed as when entering 'New' information. You may change the part number, number of pins and test data or you may skip any of the requests for entries by pressing 'Enter', in which case the tester will skip on to the next request. Otherwise the procedures for editing are the same as for entering new data.

The above may appear fairly complicated at first, but will be easy with a little practice. And remember that each routine may be saved so the test routines only have to be entered once. If an external computer is used the operation is even easier.

BINARY TO HEXADECIMAL CONVERSION TABLE

BINARY	HEX
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

* See Errata sheet which follows

PROGRAMS TO GENERATE, SEND AND RECEIVE TEST FILES WITH A COMPUTER

```
 000 'PROGRAM (ENTERTST.BAS) TO CREATE TEST FILES ON A COMPUTER
 001 'ALPHA Electronics Corporation, PO Box 1005, Merritt Island, FL  32952
 100 DIM A$(512):DIM PART$(9):GRP=1:TF$="" 'TF$=Testfile name
 110 FOR X=1 TO 512:A$(X)="0":NEXT 'Clear the array
 120 PRINT"ENTER PART NUMBER ? ";
 130 FOR Y=1 TO 8 'Up to eight digits
 140 IN$=INKEY$:IF IN$="" GOTO 140
*150 PRINT IN$;:IF IN$=CHR$(13) GOTO 170
 160 PART$(Y)=IN$:TF$=TF$+IN$:NEXT:PRINT 'Assemble file name
*170 IF Y<9 THEN PART$(Y)="0":Y=Y+1:GOTO 170 'Stretch to 8 digits
 180 INPUT"ENTER NUMBER OF PINS ";NP$
 190 IF LEN(NP$)<2 THEN NP$="0"+NP$ 'Stretch to 2 digits
 200 NP=VAL(NP$):OFFSET=(24-NP)/2
 210 X=(OFFSET*2)+1 'Offset adjusts for less than 24 pins
 220 PRINT"ENTERING DATA FOR GROUP ";GRP:PN=1
 230 PRINT"ENTER FUNCTION OF PIN  ";PN;:INPUT;PF$:PRINT
 240 X=X+1
 250 IF PF$="I" THEN A$(X)="2":GOTO 290 'In, Out, inDet, ignore
 260 IF PF$="O" THEN A$(X)="1":GOTO 290
 270 IF PF$="D" THEN A$(X)="3":GOTO 290
*280 IF PF$="X" THEN A$(X)="0":X=X+1:PD$="F0":GOTO 310
 290 X=X+1
 300 PRINT"ENTER HEX DATA FOR PIN ";PN;:INPUT;PD$:PRINT
 310 A$(X+46)=LEFT$(PD$,1):A$(X+47)=RIGHT$(PD$,1)
 320 PN=PN+1:IF PN<NP+1 GOTO 230
 330 GRP=GRP+1:IF GRP=6 THEN 370
 340 CLS:INPUT"DO YOU WISH TO ENTER ANOTHER GROUP (Y OR N) ";Q$
 350 IF Q$="N" THEN 370
 360 X=((OFFSET*2)+1)+((GRP-1)*96):GOTO 220 'Groups are 96 bytes apart
*370 X=480
 380 FOR Y=1 TO 8
 390 A$(X)=PART$(Y) 'Assemble part no for storage
*400 X=X+2
*410 NEXT
*420 X=X+2:A$(X)=LEFT$(NP$,1):A$(X+2)=RIGHT$(NP$,1)
 430 OPEN TF$+".FIL" AS 1 LEN=1
 440 FIELD 1, 1 AS B$
 450 FOR X=1 TO 512 'File must have exactly 512 bytes
 460 LSET B$=A$(X)
 470 PUT 1,X
 480 NEXT
 490 CLOSE
```

```
000 'PROGRAM (SENDTEST.BAS) TO SEND TEST FILES TO A COMPUTER
001 'ALPHA Electronics Corporation, PO Box 1005, Merritt Island, FL  32952
100 INPUT"ENTER NAME OF TEST FILE TO SEND ";TF$
200 PRINT"SENDING ";TF$;" TO COM1"
300 OPEN TF$+".FIL" AS 1 LEN=1
400 FIELD 1, 1 AS B$
500 OPEN "COM1:1200,N,8,2,CS3000,BIN" AS 2 LEN=1
600 FIELD 2, 1 AS C$
700 FOR X=1 TO 512
800 GET 1,X
900 LSET C$=B$
1000 PUT 2,1
1100 NEXT X
1200 CLOSE
```

```
000 'PROGRAM (RECVTEST.BAS) TO RECEIVE TEST FILES FROM A COMPUTER
001 'ALPHA Electronics Corporation, PO Box 1005, Merritt Island, FL  32952
100 INPUT"ENTER NAME OF TEST FILE TO RECEIVE ";TF$
200 PRINT"RECEIVING ";TF$;" FROM COM1"
300 OPEN TF$+".FIL" AS 1 LEN=1
400 FIELD 1, 1 AS B$
500 OPEN "COM1:1200,N,8,1,CS3000,BIN" AS 2 LEN=1
600 FIELD 2, 1 AS C$
700 FOR X=1 TO 512
800 GET 2,1
900 LSET B$=C$
1000 PUT 1,X
1100 NEXT X
1200 CLOSE
```

TEST ROUTINE MASTER TEMPLATE

PART NUMBER (8 Alphanumeric Digits Maximum) ________________
NUMBER OF PINS (2 Digits Maximum, Even Numbers 4 to 24) ____
GROUP NUMBER (1 to 5) __
REMARKS: ____

BINARY DATA	HEX	FUNCT	PIN#		PIN#	BINARY DATA	HEX	FUNCT
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___
____________=	___	___	____		____	____________=	___	___

ERRATA AND ADDENDUM TO THE ALPHA IC TESTER OPERATIONS AND ASSEMBLY MANUAL

THE FOLLOWING INFORMATION IS IMPORTANT TO PURCHASERS OF BOTH THE ASSEMBLED AND KIT IC TESTER. PLEASE READ CAREFULLY!!!!

Should you need to contact us for assistance please note that our phone hours are from approximately 1:00 PM to 7:00 PM Eastern time

We direct your attention to the following pages of the manual:

Page 6, paragraphs 2, 3, 4 and 5. Be sure that the test clip is not connected to an IC before performing the 'POST' test. If you connect the test clip or write your test vectors incorrectly, it is possible to scramble the storage area of the RAM. To help prevent this, when the display dims, shut off the Tester power first and remove the test clip immediately after. DO NOT REMOVE THE TEST CLIP FIRST. If the RAM becomes scrambled, follow the directions on page 6 of the manual

If the jumpers as indicated in paragraph 2 are not installed, 'ERROR ON COMM CHANNEL' will show in the display, even though there is no problem with the channel. On the DB9 connector jumper pin 2 and 7 together, and pin 3 and 8 together to perform this test.

The pins on the DB9 connector are different from those shown in the schematic for J101 and pins 1, 2, 7 and 8 are not connected together on the board. You may make these connections at J101 or on your serial cable connector at the computer's serial card if they are required. The pins of J101 are connected to the DB9 as follows (the first pin is J101 and the second is the DB9); pin 1 to 1, 2 to 6, 3 to 2, 4 to 7, 5 to 3, 6 to 8, 7 to 4, 8 to 9, 9 to 5 and pin 10 is not used. On most PC compatible serial cards connect the Tester's signal lines to the computer's serial card signal lines as follows; TXD to RXD, RXD to TXD, CTS to RTS and RTS to CTS.

Page 7, paragraph 4. Be sure to connect the test clip to the end of the cable oriented as stated, and when connecting a clip to an IC with less pins than the clip be sure that the IC is right justified in the clip, i.e., pin 7 of a 14 pin IC will contact pin 8 of a 16 pin clip, etc. Also, the test cable we supply with the assembled Testers should be connected to the 26 pin header so that the wires out of the 26 pin plug run down toward the bottom of the case.

Page 13, ENTERTST.BAS. Some bugs crept into the final version of this program. Change the indicated lines as follows:

```
150 PRINT IN$;:IF IN$=CHR$(13) GOTO 180

170 Delete this line

280 IF PF$="X" THEN X=X-1:A$(X)="F0":X=X+2:PD$="00":GOTO 310

370 X=496:Y=Y-1
380 Delete this line

400 X=X-2:Y=Y-1:IF Y<>0 GOTO 390
410 Delete this line
420 X=498:A$(X)=LEFT$(NP$,1):A$(X+2)=RIGHT$(NP$,1)
```

Page 13, SENDTEST.BAS

```
000 'PROGRAM (SENDTEST.BAS) TO SEND TEST FILES TO THE TESTER
```

Page 13, RECVTEST.BAS

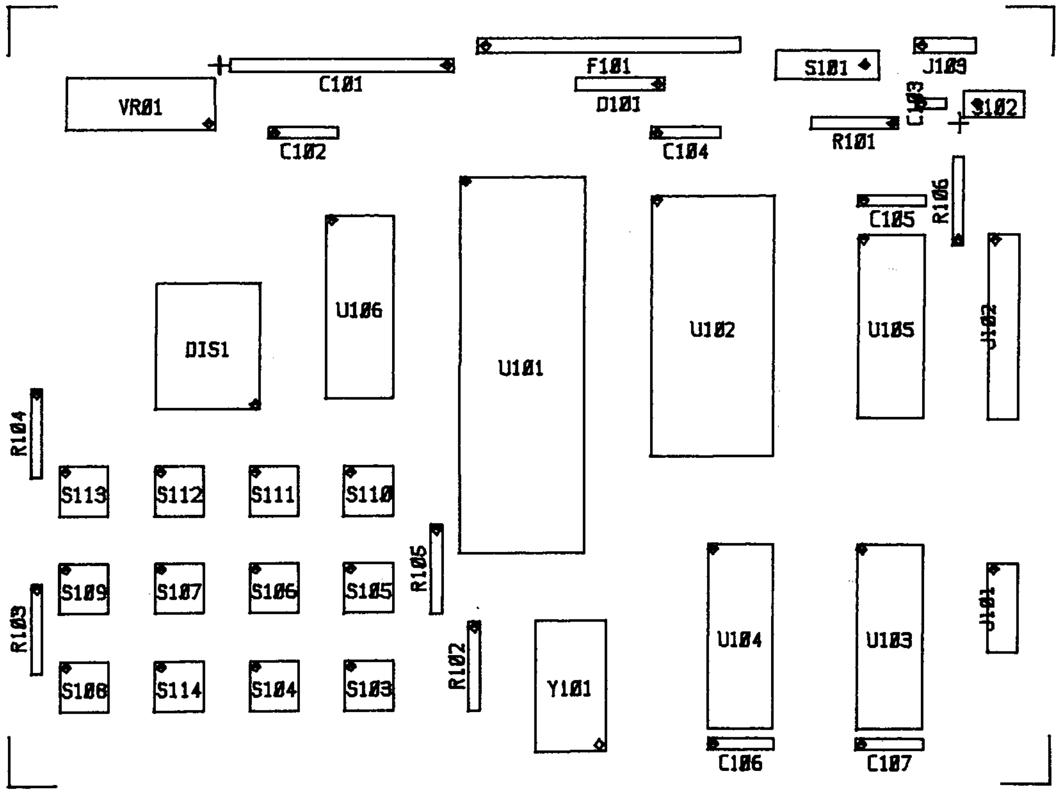
```
000 'PROGRAM (RECVTEST.BAS) TO RECEIVE TEST FILES FROM THE TESTER
```

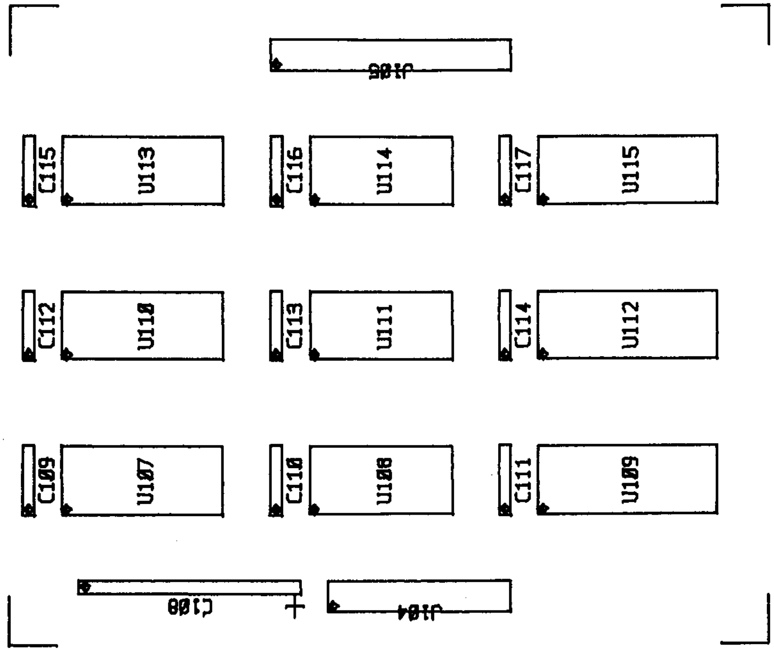
For those assembling the Tester from our kit be sure to read paragraph 8 on page 4, "When installing capacitors C111, C114 and C117...." etc., as erroneous test results will occur without these jumpers.

According to field feedback, a problem may occur during incircuit testing of IC's whose inputs are connected to the outputs of high current buffers/drivers. Although we have not been able to simulate this condition, we suspect that this might occur when the output of the buffer/driver is low and the IC-undertest's input is pulled high causing the 5 volt supply to be overloaded. As a result, the display would dim and the microprocessor would stop. It is also possible that the directory in the RAM might be overwritten when the microprocessor restarts.

In the unlikely event that you experience this problem, there are at least two ways to prevent it. The first is to connect an additional rectifier diode, filter and 5 volt regulator to the Tester's power transformer, through the power switch, to supply power to the collectors of the NE591 drivers, so that if the supply to these drivers were overloaded, the microprocessor would continue to operate normally. The second is to use the 5 volt supply of the circuit being tested to supply power to the NE591's.

In either case, cut the trace which connects pin 10 of all 3 of the NE591's to the 5 volt supply. This trace comes from pin 10 of U107 and runs to the left and under C108. Cut the trace in this area. Then connect to the trace going to U107, U110 and U113 the output of the new 5 volt supply or a lead with a test hook on the other end for connecting to the 5 volt supply of the board being tested. If you choose the later method, be sure that the Tester is on before connecting the test hook to the 5 volt supply.


VRØ1
C1Ø1
F1Ø1
D1Ø1
S1Ø1
J1Ø3
C1Ø3
S1Ø2
C1Ø2
C1Ø4
R1Ø1
R1Ø6
C1Ø5
U1Ø6
DIS1
U1Ø1
U1Ø2
U1Ø5
J1Ø2
R1Ø4
S113
S112
S111
S11Ø
R1Ø5
S1Ø9
S1Ø7
S1Ø6
S1Ø5
R1Ø3
S1Ø8
S114
S1Ø4
S1Ø3
R1Ø2
Y1Ø1
U1Ø4
U1Ø3
J1Ø1
C1Ø6
C1Ø7


J106
C115
U113
C116
U114
C117
U115
C112
U110
C113
U111
C114
U112
C109
U107
C110
U108
C111
U109
C108
J104