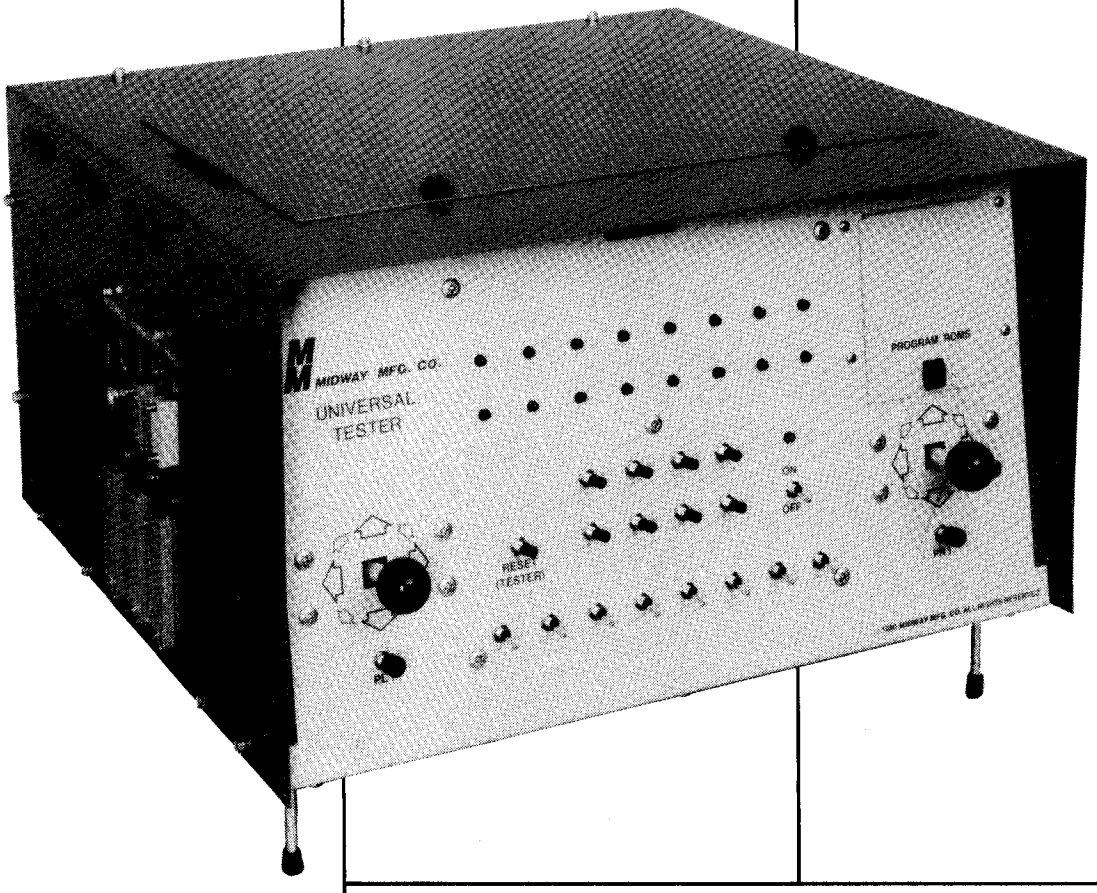
August, 1982

Bally/Midway's
Universal Tester

Parts and Operating Manual



Bally

MIDWAY MFG. CO.

10750 W. Grand Avenue
Franklin Park, Illinois 60131
U.S.A.

Phone: (312) 451-1360 Cable Address: MIDCO Telex No.: 72-1596

Form No. 0917-00300-0000

TABLE OF CONTENTS

Bally/Midway's
Universal Tester

Forward

Through the use of "state-of-the-art" computer technology, Midway has made a **TRULY** Universal Tester. In addition to being capable of operating on 115V AC @ 60Hz **your** Tester may be operated internationally on 230V AC @ 50Hz. It **IS CAPABLE** of testing **any game** developed by MIDWAY MFG. CO. to date and, because of its design characteristics, it **is capable** of testing **any FUTURE games** developed by MIDWAY MFG. CO.

The Universal Tester is a software programable device based on the Z-80 microprocessor which can address up to 64K Bytes. Therefore, basically, when a new game is developed, all **you** need do is program **your** Universal Tester with the parameters for the new game (supplied by MIDWAY MFG. CO.) and **START TESTING.**

Because of this unique design feature, **your** Universal Tester will **NEVER** become **OBSOLETE.** ANY new game need **only** be incorporated into **your** Tester's program.

Your Universal Tester comes **complete** with one Z-80 Computer Controller card, one General Purpose Input/Output (I/O) Interface card, and one General Purpose Power Supply card. This is **EVERYTHING** that is required to carry out basic testing of **most games.** The exact functions of each of these cards will be discussed in some detail later.

A complete, detailed, technical explanation of exactly how the Tester functions, including theory of operation, is available from MIDWAY MFG.CO. on request.

I. Introduction

Of course, in order for **your** Tester to be of any use to you, you **MUST** be able to communicate with each other.

As you have probably noticed, the front of **your** Universal Tester has a great many controls and indicators on it. As **you** use **your** Tester to check and/or simulate the ever increasing number of games being produced, each of these controls **WILL NOT** necessarily serve the **same function** from one game to another. BUT, they **are** the Tester's **chief means** of communication. So, how do we know what each control or indicator is telling us if its function is different for each game — or — may not even used at all??

For **EACH GAME** produced by MIDWAY MFG CO. a heavy, clear, vinyl **overlay** that fits over the front of the Universal Tester will be provided. The function of EACH control and indicator, **AS IT APPLIES TO THE GAME UNDER TEST,** is printed on the overlay.

II. Testing Philosophy

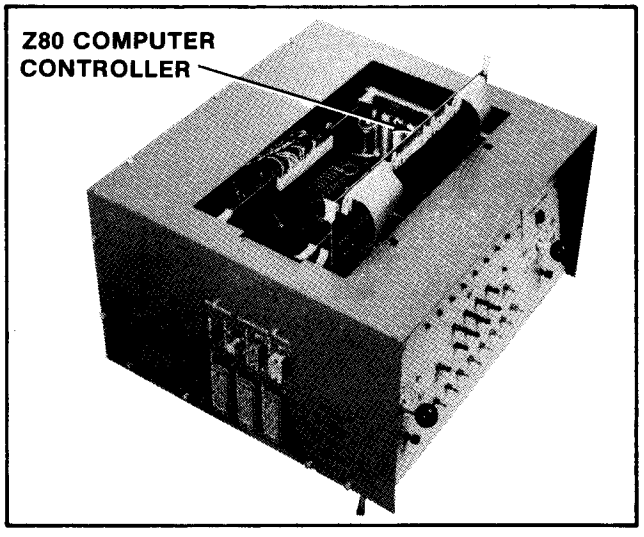
Midway's testing philosophy (at present) is a three fold one; consisting of 1.) Simulation, 2.) Stimulation, and 3.) Intelligent Diagnostics. As you progress from 1 to 3, each test is more detailed than the previous one.

1.) Simulation

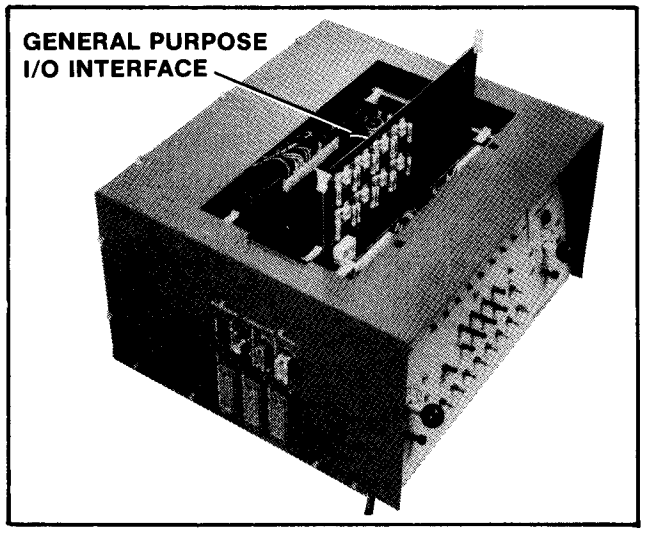
This is what **your** Tester was designed to do, its meat and potatoes so to speak. Through the use of the three cards mentioned earlier; the Z-80 Computer/Controller card, the General purpose I/O Interface card, and the General Purpose Power Supply card; **your** Universal Tester can simulate **ANY** Midway game. The functions of these three cards are as follows:

The Z-80 Computer/Controller provides separate internal and external data, address, and C.P.U. control busses for purposes of isolation when the external computer connector is in use. It also accommodates all RAM and ROM necessary to execute software commands used to interpret front panel control

signals and stimulate I/O ports with the proper patterns to simulate the control device selected by a game program. And, it is used to control any optional I/O cards used throughout the system.



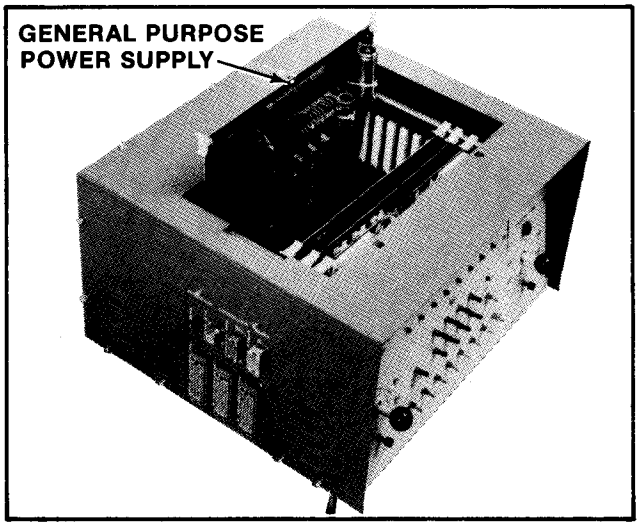
The General Purpose I/O Interface provides bi-directional control lines for use by the game under test. Several of these lines have been designed with loads equivalent to that of a typical indicator load and can be used in conjunction with the front panel L.E.D.'s to indicate game modes, etc., and effectively simulate the indicator that would be used in the actual game. All lines are available when using the Computer/Controller to simulate control devices such as angle encoders, optical encoders, switches, etc.



The General Purpose Power Supply provides **ALL** the voltages necessary, other than the standard computer voltages, to operate **MOST** games., It is **also capable** of providing A.C. voltages by means of hardware interconnections to the backplane buss for use throughout the system.

Basically, what **your** Tester is actually doing when it is in the "SIMULATION" mode is acting as though it were a game that is being played. The game component that you wish to test is simply plugged into the Tester via its I/O jack. The component under test **CANNOT** tell that it is not actually in an arcade game which is being played.

You then see if the component performs properly. If it does, you go to the next component you wish to test. If it does not, you troubleshoot it farther by standard means or by going to the next level of testing — STIMULATION (signature analysis).



2.) Stimulation (signature analysis):

In this mode **your** Tester gives instructions to the component under test to perform a function that, if it were working properly, it should be able to do. Then, by using a signature analyzer and knowing what signature you are looking for at a given point, you can determine whether the component under test, or a portion of it, is bad.

3.) Intelligent Diagnosis:

The next and most complex level of testing is a type of intelligent diagnostics. In this mode of operation — the computer in **your** Tester talks **directly** to the computer in the game under test. It can tell the game's computer to do tests on itself and display the results on its screen or send it back to the Tester for display in a manner you have selected.

This mode of operation can also be used in combination with the "STIMULATION" mode to direct your signature analyzers probe and thus speed up your troubleshooting efforts.

It should be noted that the Intelligent Diagnostics Interface card required may change from hardware system to hardware system. However, by allowing the Universal Tester to be able to utilize different cards of this type, **IT IS CAPABLE** of communicating DIRECTLY with **ALL** types of other Microprocessors i.e., the 8080, 6800, Z8000, and the 68000 to name a few.

III. Location and Setup

INSPECTION:

1. Remove the Tester from its shipping crate.
2. Inspect the entire outside of it for any signs of damage.
   - ☐ Any scratches?, dents?, cracks?
   - ☐ Any broken controls?
   - ☐ Any missing parts?
   - ☐ Just look it over closely and make a note of any signs of damage or missing items.
3. Install the two short Elevator Legs which raise and tilt the Tester's Front Control Panel toward you, making the Controls easier to see and use. See Figure 3-1.
4. Remove the Tester's Chassis Cover and inspect its inside areas for any signs of damage. See Figure 3-1.
   - ☐ Also check to make sure all plug-in connectors on the wire harness are firmly seated.

   NOTE: ALL connectors or plugs are keyed so they will only go together when all pins are properly lined up.
   - ☐ Replug any connectors found unplugged. DO NOT FORCE PLUGS ONTO CONNECTORS. DO NOT FORCE PLUGS TOGETHER. If it won't go on easily, assuming the keys are lined up, it either does not belong there or is damaged.
   - ☐ Make sure all printed circuit boards (P.C.B.'s) are firmly seated in their connectors. See Figure 3-1. These connectors are also keyed. The P.C.B.'s will only go into them one way without being damaged.
   - ☐ Note the location of the Tester's serial number. See Figure 3-1.
   - ☐ Check all major subassemblies to be sure they are mounted securely. These are called out in Figure 3-1.

     Lambda Power Supply.
     Power Supply Transformer.
     Control Panel.
     Other P.C.B.'s and/or P.C.B. Rack, etc.
5. Make a note of any problems that can't be easily corrected.
6. Call your distributor and/or the Factory Service Department about your problem list.

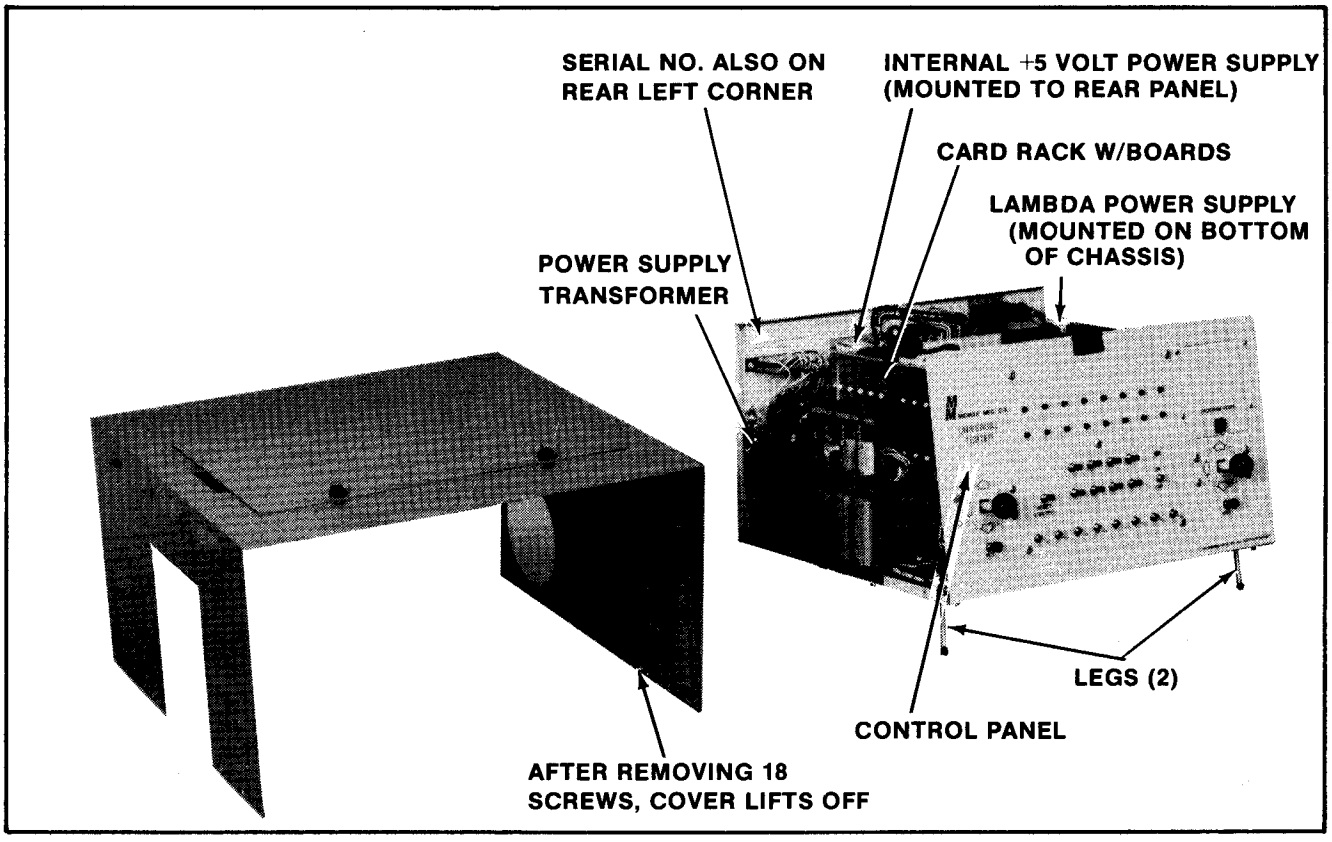


Figure 3-1

Installation:

1. Location requirements:
   - ☐ **Power:**
     Domestic 115 V @ 60 Hz
     Foreign 230 V @ 50 Hz
   - ☐ **Temperature:** 32° to 100°F (0° to 38°C)
   - ☐ **Humidity:** Not over 95% relative
   - ☐ **Space required:** 17" x 16" (43 x 41 cm)
   - ☐ **Height:** 9.5" (24 cm)

2. Voltage Selection:

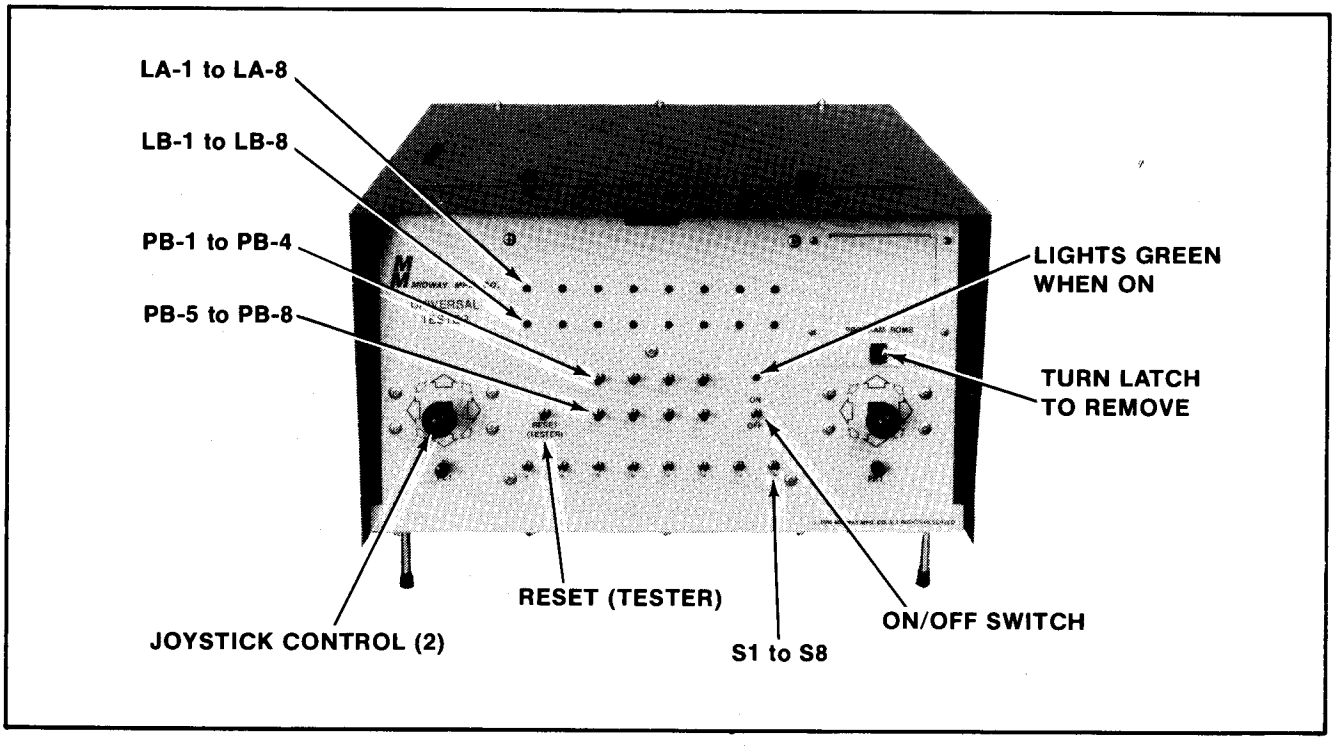
   Your Tester is designed to work properly on the line voltage where you are located. Check your line voltage with a meter to determine what its value is. The line voltage in your area may vary from the above stated operating voltages by as much as PLUS or MINUS 10%.

   If the line voltage in your area falls outside the upper or lower limits of the above stated range for proper operation of your Tester, **DO NOT PLUG YOUR TESTER IN** until you have talked with your Distributor and/or the Factory Service Department and obtained a solution to this problem. Otherwise you could damage your Tester.

IV. Universal Tester Operations Section

TESTER GENERAL DESCRIPTION:

The Universal Tester's Front Panel Contains the Following Indicators and Controls:



1. Two Joystick Controls.
2. Below each of these is a Push Button.
3. Top center of Panel has two rows of 8 LEDs each: LA-1 through LA-8 and LB-1 through LB-8 respectively.
4. Below these are two rows of 4 Push Button Switches each: PB1 through PB4 and PB5 through PB8 respectively. These are all of the "PUSH-ON" type.
5. Just to the left of PB5 is another Push Button Switch which is marked "RESET (TESTER)".
6. Just to the right of PB8 is the master ON/OFF Toggle Switch for the Tester. It has a Green LED connected to it which indicates that power is applied to the Tester. (Generally speaking, if this Green LED is not lit, power is not ON to the Tester.)
7. Just below these is a row of 8 Toggle Switches: S1 through S8. These are of the "ON/OFF" type. There is NO center position.

8. In the upper right hand corner of the Tester's Front Panel is a removable Cover (secured with a nylon turn latch).

   Under this Cover are two green Zero Insertion Force Sockets (ZIF's for short). These are marked as being positions "0" and "1"

NOTE: This Cover cannot be installed and secured in place if the actuation lever(s) on the ZIF Socket(s) are in their forward position.

   These Sockets hold the ROMs which specify the way in which the Tester will operate.

   Just to the right of ZIF Socket "0" is a Jumper Connector. The bottom position is marked "A", the top position is marked "B", and the center position is marked "1".

   This Jumper Connector has to be moved depending on which type of ROM is to be inserted into the ZIF Sockets. The Jumper Connector should be installed between "1" and "A" for a 2716 ROM and between "1" and "B" for a 2732 ROM.

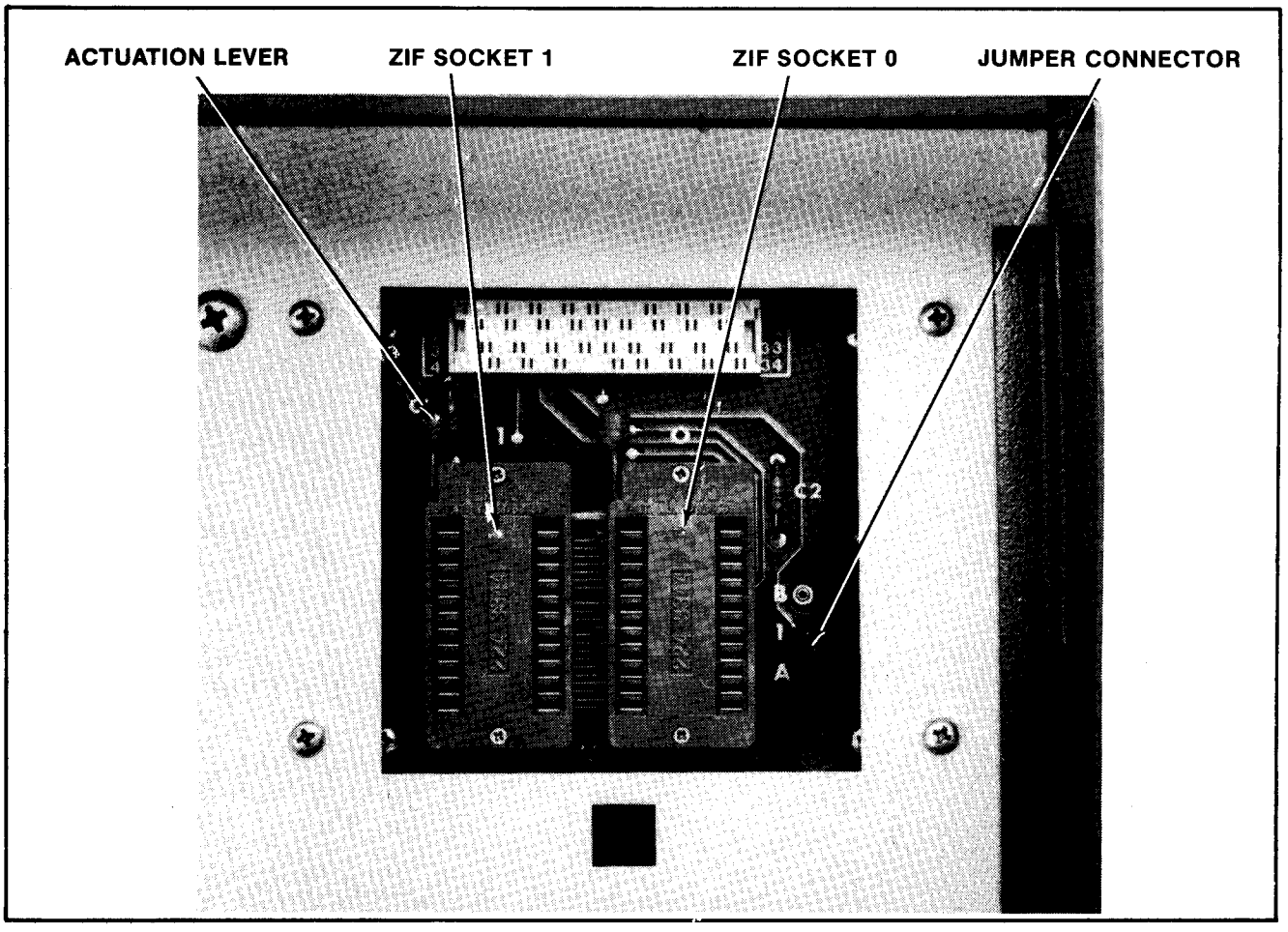
   A 2716 ROM HAS 2000 BYTES OF MEMORY CAPACITY
   A 2732 ROM HAS 4000 BYTES OF MEMORY CAPACITY

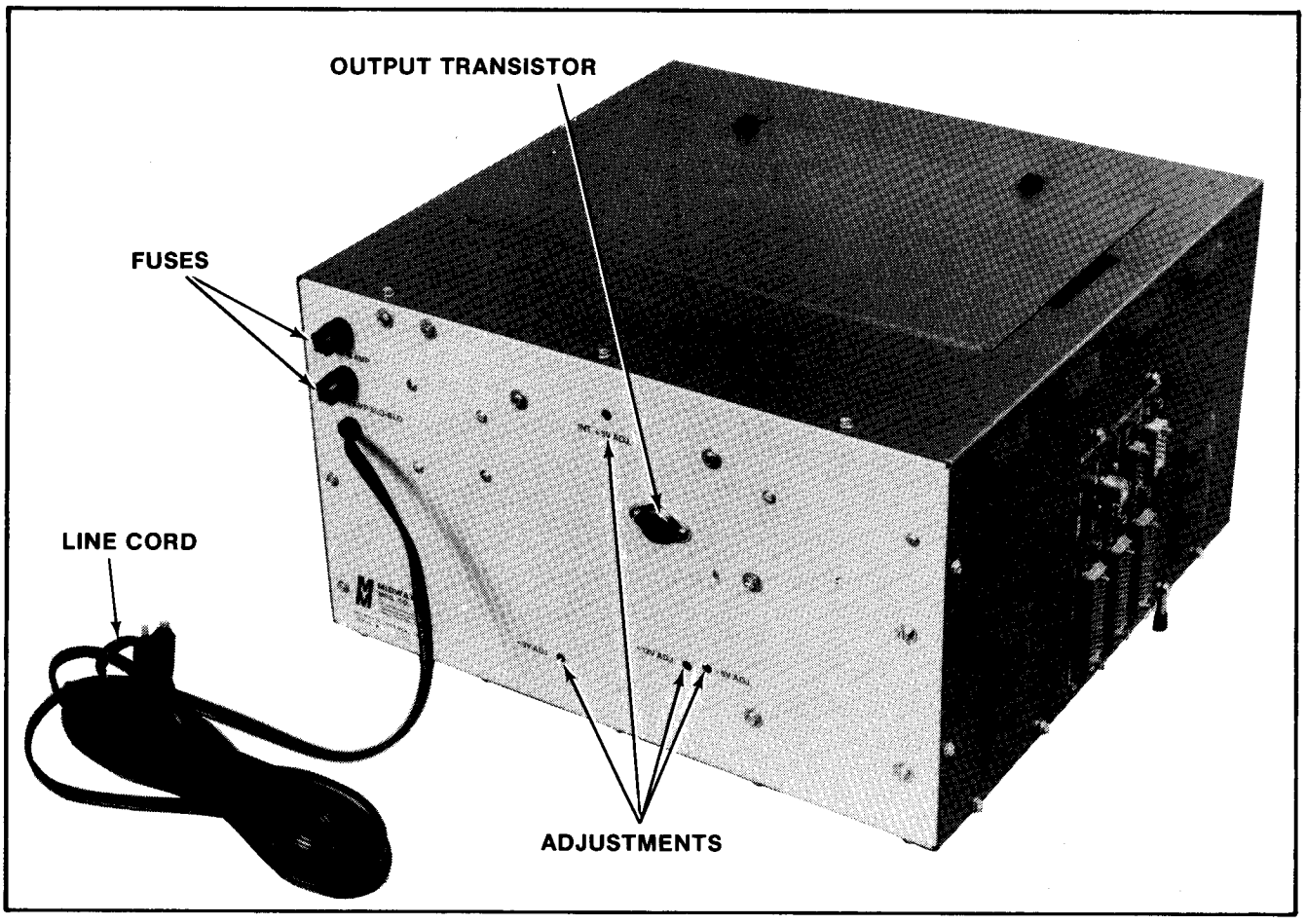
   This means that the total capacity of both ZIF Sockets can be either 4000 or 8000 bytes of memory capacity.

   To insert a ROM in the ZIF Socket: The actuation lever **MUST** be forward (this opens the contacts which will grip the legs of the ROM). The ROM is inserted in the ZIF Socket with its index mark up (toward the top of the Tester). Push the actuation lever back against the P.C. Board the ZIF Socket is mounted on to secure the ROM in place. If you have **ONLY** 1 ROM to install, **ALWAYS** USE ZIF SOCKET "0". If you have 2 ROMs to install, THEY WILL BE MARKED "0" AND "1".

9. To use the Overlays provided, select the one you need for the test you wish to perform, insert its top edge under the Spring Clip at the top center edge of the Tester's Front Panel, and fit the holes in the Overlay over the LEDs and Switches on the Front Panel. The Overlay **MUST** be readable. If you can't read it after you've installed it, remove it, re-orient it, and reinstall it.

   The Overlay specifies the different functions/indications for each Front Panel Control/Indicator it physically covers. These **ARE NOT NECESSARILY THE SAME** for all games. In fact, they **WILL** change.





The Universal Tester's Back Panel Contains the Following Items and Adjustments:

1. Two Fuse Holders located in the upper left hand corner as you face it.

   These Fuses are for: "+5 VOLTS INTERNAL" rated at 8 AMPS Normal Blow.
   "LINE VOLTS" rated at 2½ AMPS Slow-Blow

   NOTE: The +5 VOLTS INTERNAL Fuse is **ONLY** for the Power Supply that provides +5 Volts to the P.C. Boards and components **INSIDE THE TESTER'S CHASSIS.**

2. Just below these two Fuse Holders is where the Tester's Line Cord comes out of its Chassis.

3. In the top center of the Rear Panel of the Tester is the "INTERNAL +5 VOLTS ADJUST". The "under load" adjustment range for this voltage is +4.8 Volts to +5.6 Volts.

4. Just below and to the right of the above adjustment pot is the Output Transistor for the Internal +5 Volt Supply.

   NOTE: The Internal +5 Volt Supply is rated at +5 Volts @ 5.5 Amps.

5. Just below this +5 Volt Output Transistor we have three inter-related adjustments. These adjust the standard computer supply voltages that go out to the devices under test. These voltages are labeled as follows:

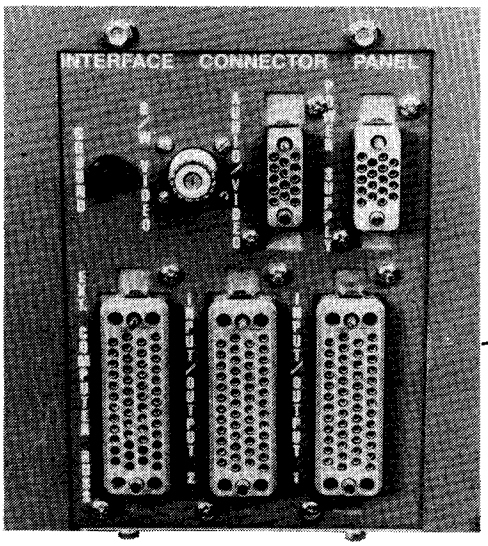
   +5 Volts @ 7 Amps
   +12 Volts @ 1 Amp
   −5 Volts @ 1 Amp

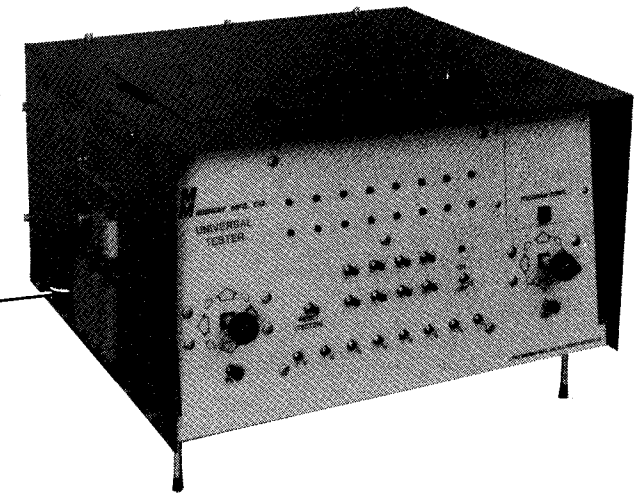
6. And at the extreme lower left hand corner is your Tester's Serial Number. If you have any questions and you are writing to the company, be sure to include your Serial Number.

The Universal Tester's Left Side (As You Face the Front) Contains an Interface Connector Panel:

This Panel has 4 smaller Connectors in its top row and 3 larger ones in its bottom row. The Multi-pin Plugs are all military Rack and Panel style Connectors selected for their durability and long life characteristics.

1. The upper right hand Connector (as you face this Interface Connector Panel) is the Power Supply Connector. This provides +5 Volts, +12 Volts, −5 Volts, Ground, and any Auxiliary Voltages generated on the General Purpose Power Supply P.C. Board (or any Auxiliary Power Supply Board for that matter) to the Device Under Test.





NOTE: The +5, +12, and −5 Voltages are generated by an O.E.M. Linear Power Supply manufactured by "LAMBDA".

2. The Audio/Video Connector supplies all the lines needed to pass audio and video information between the Device Under Test and the Tester.

3. The Black & White Video Connector is just tapping off on one line of the Audio/Video Connector. This is the composite video output for black and white **raster scan** monitors.

   NOTE: This Connector **IS NOT** used for black and white **vector scan** monitors.

4. The Ground Banana Jack is a means by which you can connect either a Ground Probe or interface your Scope, or Meter, or anything to the ground reference for the Tester.

   It can also be used to tie the ground of the Device Under Test to the ground reference of the Tester. This then assures that the grounds of both systems are at the same potential.

5. Input/Output 1 and Input/Output 2 are sometimes used individually and sometimes in conjunction with each other. They interface directly with the 100 Pin Connectors that are on the Backplane of the Tester's Card Rack. Their basic function is to provide a means of connecting the P.C. Boards in the Tester's Card Rack with the outside world.

   What I/O 1 and I/O 2 will do with regard to any particular device that is under test is **COMPLETELY DEFINED** by the P.C. Boards installed in the Tester's Card Rack and the Program ROMs.

6. The External Computer Buss is a completely separate and independently buffered Computer Buss directly connected to the CPU in the Tester.

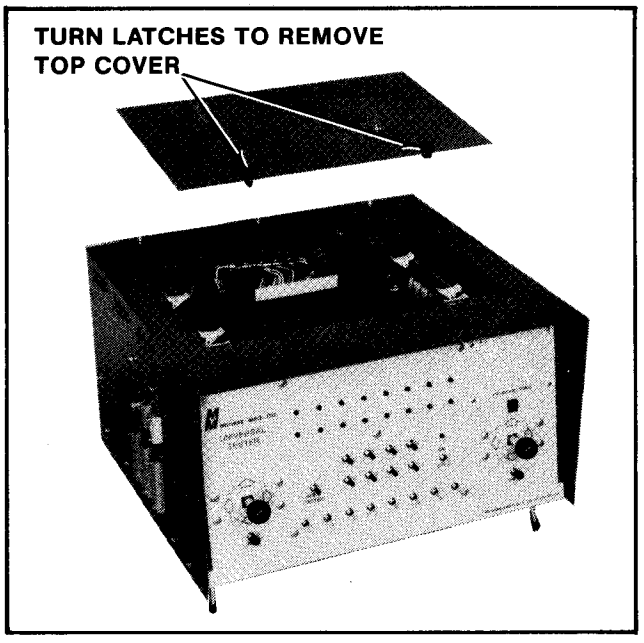
   What this means is that this is a method by which we can provide computer control to test boards that are computer controlled in the game where they are used.

   The primary advantage here is that this Computer Buss is **INDEPENDENTLY BUFFERED** so that if something bad should happen **TO** or **IN** the Device Under Test, this **CANNOT** harm the Computer in the Tester. In addition, if something should load down the external data address and control signals this **INDEPENDENT BUFFERING** will not allow the internal data, address, and control to also become loaded down. Thus, we now can do an analysis of what has happened to those external data, address, and control signals.

The Universal Tester's Top Contains a Cover Which Gives Access to the Tester's Card Rack:

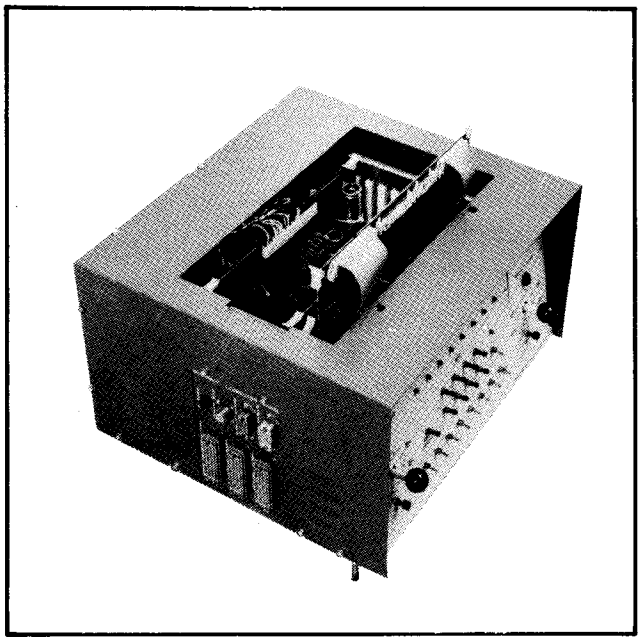
This Cover is secured in place with 2 Nylon Turn Latches. Under this Cover is the Tester's Card Rack which holds all the P.C. Boards required to operate the system. You will note that there is an indentation on the left side of this Cover to provide access for any external cables that may be required in the future; such as ribbon cables to come in and connect to the Interface P.C. Boards that will be held in the Tester's Card Rack.

There are 4 P.C. Boards supplied as standard equipment with each Tester: 1) The Computer Controller P.C. Board which is in the 1st slot in the Card Rack; 2) The General Purpose I/O P.C. Board which is in the 2nd slot; 3) The Video Signal Interface P.C. Board which is in the 3rd slot; and 4) The General Purpose Power Supply P.C. Board which is in the 9th and last slot of the Tester's Card Rack.

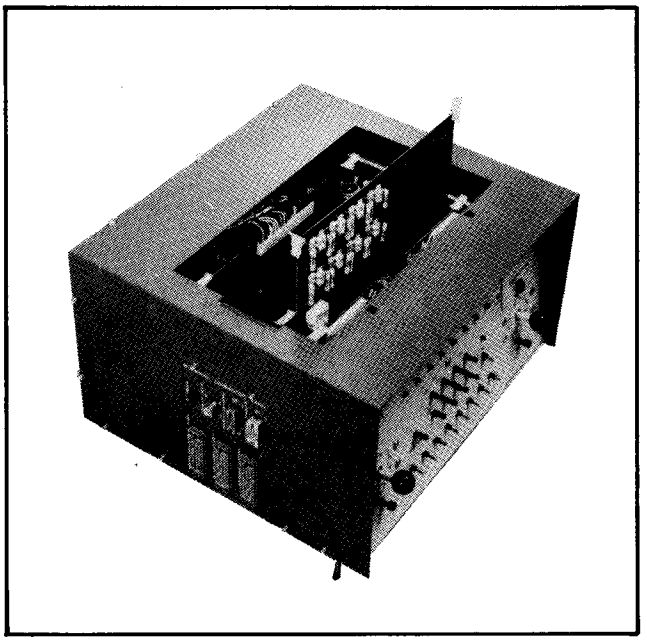


NOTE: The slots in the Tester's Card Rack are numbered 1 through 9 from Front Panel to Back Panel as you face the Tester's Front Panel.

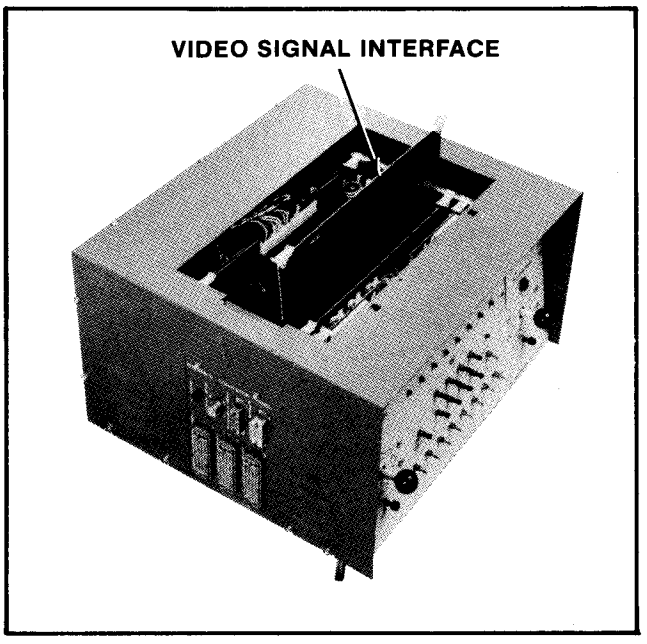
1. The Computer Controller P.C. Board in slot 1 has 4 Connector Plugs along its top edge. These are — from right to left as you face it — the External ROM, or "USER" ROM Connector which connects the ROM(s) in the Front Panel ZIF Sockets to the Computer Controller; the Auxiliary External Buss Connector which will be used for as yet unspecified Auxiliary P.C. Boards; the External Computer Buss Connector which goes to the Connector by the same name on the Tester's left side Interface Connector Panel; and the Front Panel Connector which connects all the Tester's Front Panel Controls and Indicators to the Computer.



2. The General Purpose I/O P.C. Board in slot 2 has no additional plugs or connectors on it. It is used for interfacing **INPUT** signals to the Tester **FROM** the Device Under Test and for interfacing **OUTPUT** signals from the Tester **TO** the Device Under Test.

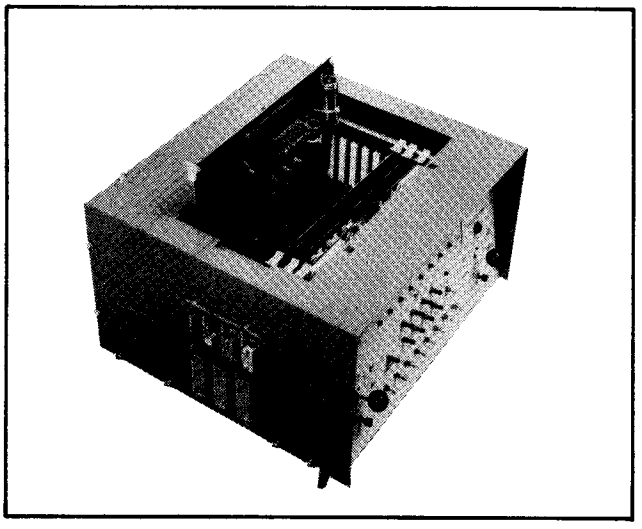


3. The Video Signal Interface P.C. Board in slot 3 has one Connector on its top left hand side. This is the Video Output Connector. This P.C. Board is basically a blank. Its main function is to provide signal paths for video signals going through the Tester. It occupies the space where a Video Generator P.C. Board would be installed if this option were purchased.



4. The General Purpose Power Supply in slot 9 has one Connector in the center of its top side. This is the AC Input Cable Connector. This General Purpose Power Supply is replaceable with any kind of Auxiliary Power Supply based on the power needs of any given system you wish to test.

   Power Supply P.C. Boards are **typically** installed in slot 9 of the Tester Card Rack Backplane and will **typically** contain component parts which will project out far enough to prevent a P.C. Board from being installed in slot 8 in the Card Rack Backplane.



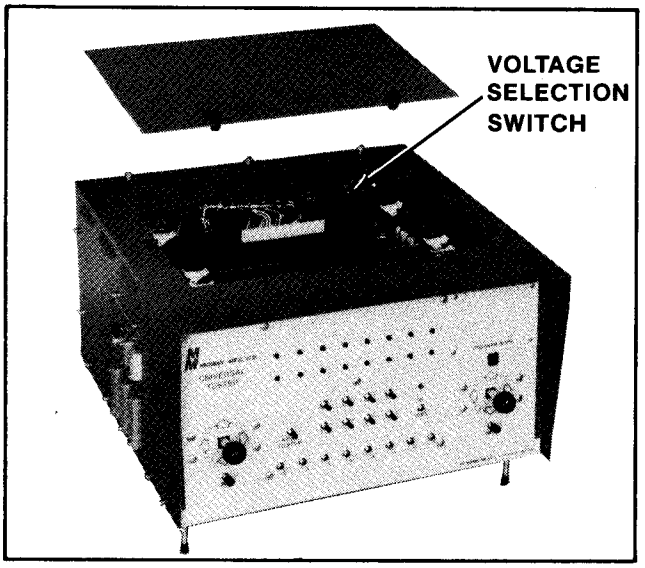
NOTE: Any auxiliary DC voltages that are provided by the General Purpose Power Supply P.C. Board are fused on that P.C. Board. The General Purpose Power Supply P.C. Board supplied with your Tester happens to have 5 — V-Audio, V-LED, V-Pulsating, +15 Volts, and −15 Volts.

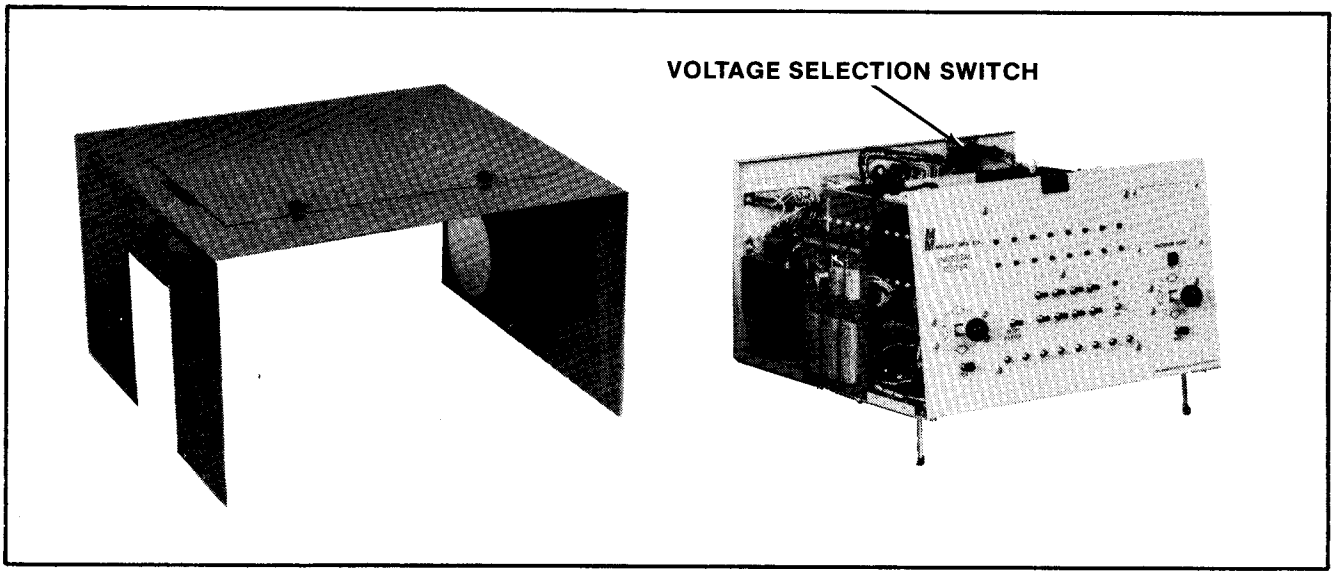
AC voltages that are transfered out of the Tester for games that operate on AC (like PAC-MAN)— **ARE NOT FUSED.** The reason these AC voltages are not fused is that there are so many different combinations that it would be impractical. There would have to be a P.C. Board full of nothing but fuses. So, **BE VERY CAREFUL** when using these voltages.

Voltage Selection Switch:

Also accessible through the top Cover of the Tester is the "115-DOMESTIC/230-FOREIGN" Voltage Selection Switch. It is mounted at the very back top right hand corner of the Tester's Chassis as you face the Front Control Panel. This Switch is set (as you face it) all the way to the left (115 VOLTS-DOMESTIC) at the factory.

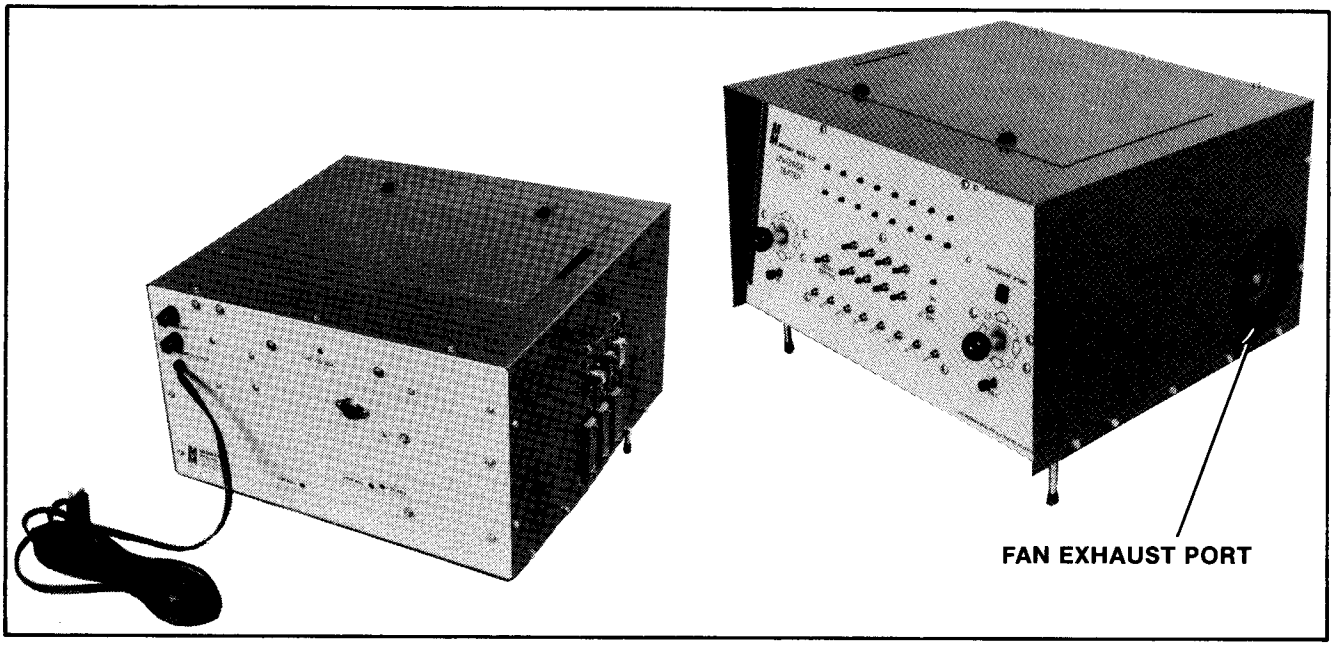
If you should wish to change it, **turn the Tester OFF,** and slide the Switch to the right (230 VOLTS-FOREIGN) using a nylon or plastic rod. **DO NOT** attempt to throw this Switch with your **BARE HAND!!** (for your convenience, you may wish to remove the Tester's Cover from its Chassis to do this.)





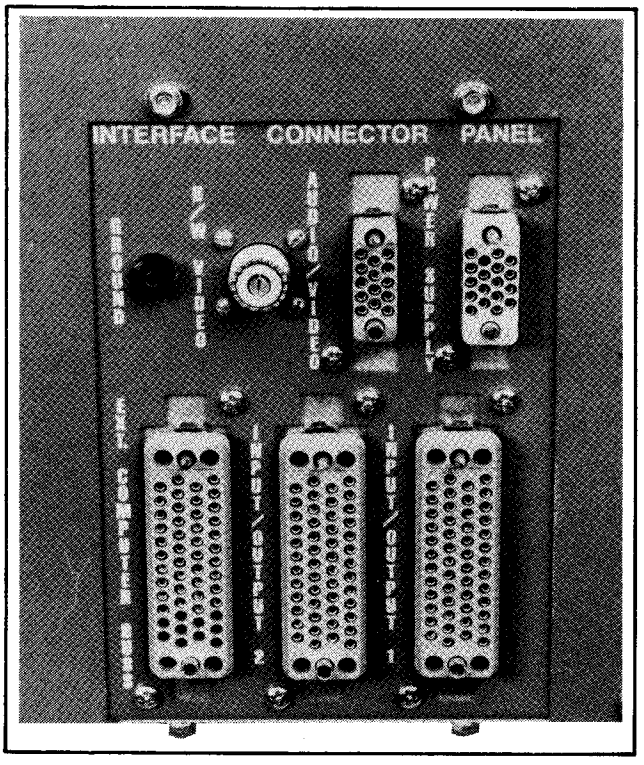
Tester Ventilation:

You will notice that the ONLY thing on the right side of the Tester (as you face it) is the Fan exhaust port. On the left side of the Tester you can see that numerous vent louvers have been cut into the Chassis Cover. ALL of the above ports and louvers should be kept free from obstructions to promote proper cooling of the Tester. In your Tester there is a lot of electronics packed into a very small space. So **BE SURE** you follow this advice on how to keep from overheating or "cooking" any of your Tester's **expensive** component parts.



V. Universal Tester Self-Test

The Self-Test Code for your Tester is contained in the Executive Program. And the Executive Program is contained in the Tester's Executive ROM which is supplied as part of **EACH** Tester's hardware. This means that your Tester is "SMART" just as it is — right out of its shipping box. Without installing a User ROM, your Tester is **FULLY CAPABLE** of performing a complete Self-Test on itself. With the installation of User ROMs, your Tester becomes **FULLY OPERATIONAL.** Before — it was only "SMART". When you install the User ROMs — you give your Tester its College Degree so to speak.



Accessing the Self-Test Function On Your Tester:

You may have equipment plugged into the Jacks in the Tester's Interface Connector Panel with the exception of I/O 1 and I/O 2. **NOTHING AT ALL** should be connected to these two Connectors. This is because you will need to plug a Test Connector in there later, when you get to that part of the Self-Test procedure.

The sequence that the Self-Test is carried out in is as follows:

1. The Self-Test is performed in conjunction with the General Purpose Overlay.

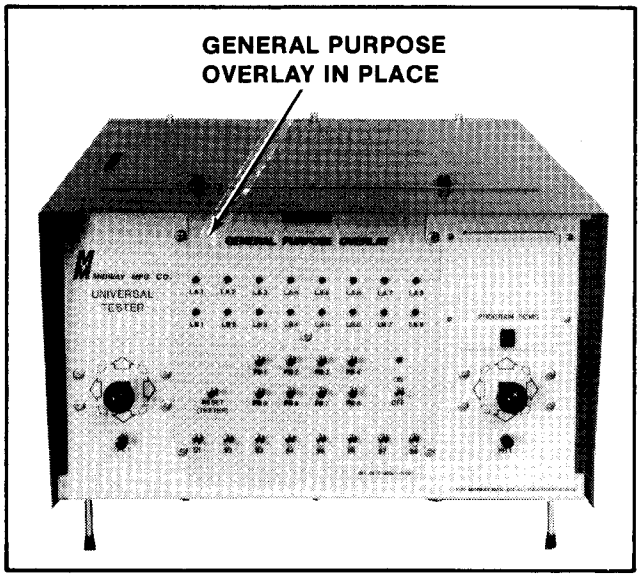
2. On the General Purpose Overlay there are two Self-Test functions which can be initiated:

S7 "ON" = **SYSTEM SELF-TEST**
S7 "ON" + S8 "ON" = **G.P. I/O SELF-TEST**

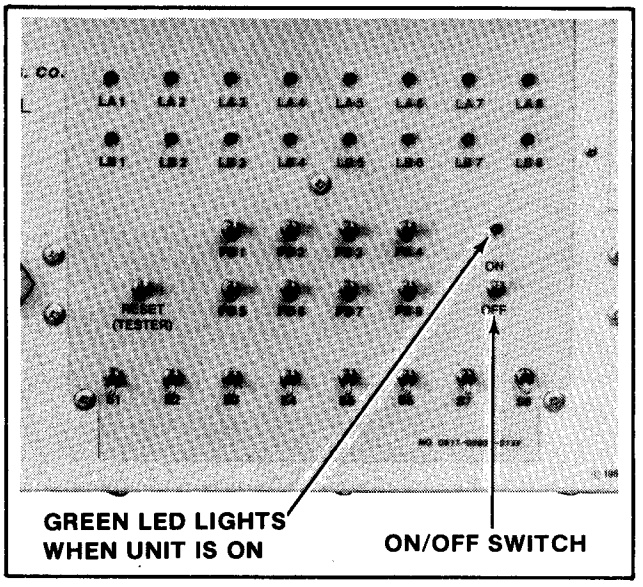
NOTE: On all other Overlays — these will be called out as: **SELF-TEST** and **G.P. I/O SELF-TEST.**

Once you become familiar with the Self-Test functions, you will be able to immediately tell if there is anything wrong with your Tester or not.

This Self-Test procedure will alert you to: A Tester ROM failure, A Tester RAM failure, A Tester I/O failure, A Tester Control failure, and/or A Tester Indicator failure.



3. When you flip the Tester "ON/OFF" Switch to the "ON" position (all other Switches "OFF"), the Green LED above it comes on and you can hear the ventilation Fan start up. That is all that will happen right now.



What the Tester is doing at this time is asking the Executive Program "What am I going to do?". It is looking for a task to perform. If you had a game code installed, it would start executing the game. If you had an intelligent test code installed, it would start executing the intelligent test routine.

The Tester **WILL NOT** do a Self-Test on itself **UNLESS YOU ASK IT TO.** Following is the correct way to ask it to perform this test in itself.

4. Throwing Switch S7 to the "ON" (up) position and pushing the "RESET (TESTER)" Push Button initiates Tester Self-Test.

NOTE: Switches S7 and S8 are multipurpose Switches and are **ONLY READ** for a Self-Test request **AFTER A TESTER RESET.**

5. **IF ALL IS WELL,** the Front Panel LEDs will sequentially flash continuously in a counterclockwise direction throughout, beginning with LA-8. This test indicates that those 16 LEDs are good and can be turned "ON" from an "OFF" condition.

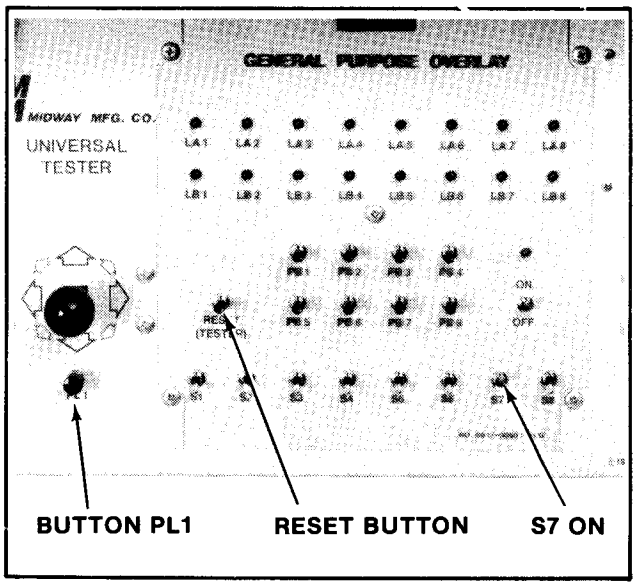
NOTE: Prior to the LEDs beginning their above flashing sequence, the Tester has conducted a ROM and a RAM test on itself. It gives no indication of this if everything checks good.

However, if everything IS NOT well:

- ☐ If a ROM is bad, LA-1 will light up indicating that you have a ROM failure.
- ☐ If a RAM is bad, LA-2 will light up indicating that you have a RAM failure.

If either LA-1 or LA-2 light and stay lit, turn to the "ROM/RAM FAILURE TEST" section of this manual for further direction on how to determine what the problem is.

6. Assuming the LEDs began sequentially flashing after you pressed the "RESET (TESTER)" Push Button, now press Push Button PL1.



All the LEDs turn "ON" and they now flash "OFF" sequentially in a counterclockwise direction throughout beginning with LA-8. This test indicates that these 16 LED's are good and can be turned "OFF" from an "ON" condition.

7. Press Push Button PL1 again to enter the Front Panel Test. This test monitors each Switch and Push Button on the Front Panel (excluding the "ON/OFF" and "RESET (TESTER)" Switches) with the Tester's LEDs. The relationship between the Tester's Controls/Switches and the LEDs is as follows:

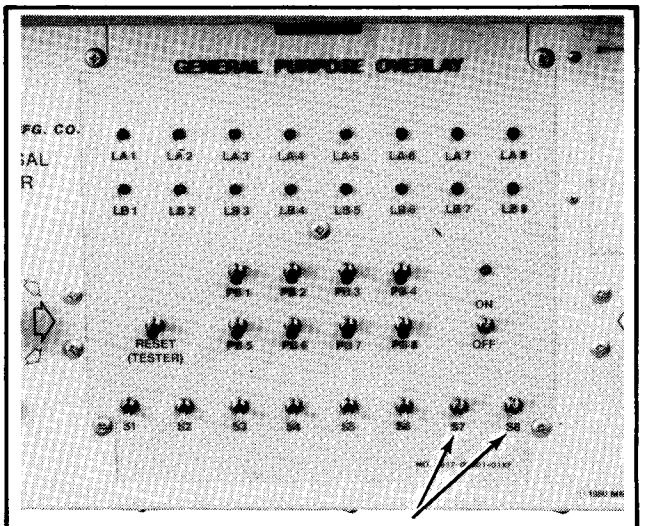
PL1 = LB-1 LIGHTS
LEFT JOYSTICK DOWN = LB-2 LIGHTS
LEFT JOYSTICK LEFT = LB-3 LIGHTS
LEFT JOYSTICK UP = LB-4 LIGHTS
LEFT JOYSTICK RIGHT = LB-5 LIGHTS
PR1 = LA-1 LIGHTS
RIGHT JOYSTICK DOWN = LA-2 LIGHTS
RIGHT JOYSTICK LEFT = LA-3 LIGHTS
RIGHT JOYSTICK UP = LA-4 LIGHTS
RIGHT JOYSTICK RIGHT = LA-5 LIGHTS
PB1 = LA-1 LIGHTS
PB2 = LA-2 LIGHTS
PB3 = LA-3 LIGHTS
PB4 = LA-4 LIGHTS
PB5 = LA-5 LIGHTS
PB6 = LA-6 LIGHTS
PB7 = LA-7 LIGHTS
PB8 = LA-8 LIGHTS
S1 = LB-1 LIGHTS
S2 = LB-2 LIGHTS
S3 = LB-3 LIGHTS
S4 = LB-4 LIGHTS
S5 = LB-5 LIGHTS
S6 = LB-6 LIGHTS
S7 = LB-7 LIGHTS
S8 = LB-8 LIGHTS

8. **THIS COMPLETES THE TESTER SELF-TEST.** If you have gotten to this point, the Tester is qualified as good. You've tested the ROM. You've tested the RAM. You've tested the LEDs so that you know they are good and can indicate failures to you. And you've tested the Switches.

G.P. I/O Channel Test:

The next Self-Test you will want to perform is the G.P. I/O Channel Test.

1. To do this, **BOTH S7 AND S8 MUST** be in the "ON" (up) position. If S8 is "ON" alone, nothing will happen. And if S7 is "ON" alone you will get the Tester Self-Test, **NOT** the G.P. I/O Channel Test.



S7 and S8 ON

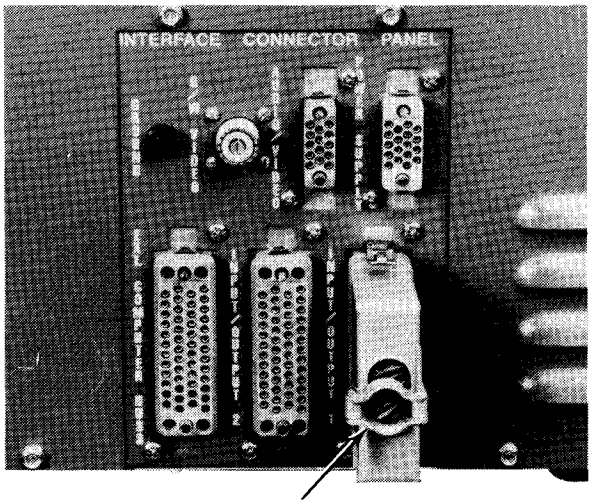
2. Insert the I/O Test Connector into the I/O 1 Connector on the Tester's left side Interface Connector Panel. This Connector is "Keyed", as are they all, to prevent accidental up side down installation.

3. Now, after performing the Self-Test and having confidence that the Tester and its CPU P.C. Board are good, you will want to check the I/O P.C. Board to verify that the I/O Channels are working properly.

4. To begin the test, press the "RESET (TESTER)" Push Button.

   IF ALL IS WELL both rows of LEDs will "trace" **FROM** LA-8 and LB-8 **TO** LA-1 and LB-1 at the **SAME** time. (This looks similar to the moving displays of lights sometimes seen on a theater marquee.)

   When you see the above type of display, the Tester is 100% qualified as good.



I/O TEST CONNECTOR

G.P. I/O Channel Test Failure Modes:

1. The most obvious Failure Mode is trying to perform the G.P. I/O Channel Test without the G.P. I/O Test Connector installed in I/O 1. This problem would be indicated to you after pressing the "RESET (TESTER)" Push Button by: LEDs LA-1 through LA-8 being "ON" — indicating that all the bits have failed; and LB-1 through LB-8 are flashing ON and OFF together — indicating that the Computer is completely confused (it has looked at the I/O P.C. Board and the I/O Connector and has found so many errors that it cannot determine what is wrong. So it is saying to you "forget it, **YOU** tell **ME** what you did.")

2. In testing the I/O Channels, it is imperative that you know how the test is actuated.

   Four 8 bit Channels are available (32 bits total). The Tester outputs this test data on one Channel at a time and reads it back on the other three. Then the Tester advances one Channel, outputs the data again, and reads it back on the other three, etc. The following table illustrates this procedure.

STEP 1	**CHANNEL A = OUTPUT** **CHANNEL B = READ** **CHANNEL C = READ** **CHANNEL D = READ**
STEP 2	**CHANNEL B = OUTPUT** **CHANNEL C = READ** **CHANNEL D = READ** **CHANNEL A = READ**
STEP 3	**CHANNEL C = OUTPUT** **CHANNEL D = READ** **CHANNEL A = READ** **CHANNEL B = READ**
STEP 4	**CHANNEL D = OUTPUT** **CHANNEL A = READ** **CHANNEL B = READ** **CHANNEL C = READ**

For Multiple Failures — The Tester's Diagnostic Display May Be Translated As Follows:

3. LB-1 through LB-4 indicate what Channel the Tester is outputting from (LB-1 = Channel A, etc.) and LB-5 through LB-8 indicate what Channel the Tester is reading from (LB-5 = Channel A, etc.).

4. LA-1 through LA-8 indicate which bit of any particular channel is failing. By pressing Push Button PL1 successively, you will instruct the Tester to step through each of the above described modes. You can now watch step by step as the Tester outputs from Channel A and then reads from Channel B, Channel C, Channel D, and so on.

5. At the end of the test, after all problems have been resolved, the LEDs will trace.

For Single Failures — The Tester's Diagnostic Display May Be Translated As Follows:

6. When there is a single failure, quite a bit of detailed diagnostic information is made available to the operator:

   - ☐ LB-1 through LB-4 indicate what Channel is failing (A through D respectively).
   - ☐ LB-6 and LB-7 indicate what mode the above Channel is failing in (LB-6 = INPUT and LB-7 = OUTPUT).
   - ☐ LA-1 through LA-8 indicate which bits have failed (LA-1 = BIT 7 through LA-8 = BIT 0 respectively).

7. At the end of the test, after all problems have been resolved, the LEDs will trace.

ROM/RAM Failure Test

The purpose of this section is to explain the detailed use of the Tester's ROM/RAM failure diagnostics so that you can determine what is wrong with your Tester and fix it.

As stated previously, **IF EVERYTHING IS NOT WELL** when you enter this test, you will see that either LA-1 or LA-2 has lit and stayed ON.

1. If a ROM is bad, LA-1 will light up indicating that you have a ROM failure.

   - ☐ LB-1 through LB-4 will light up indicating which ROM has failed.

     LB-1 = position "0" (location A6) on Computer Controller P.C. Board.

     LB-2 = position "1" (location A7) on Computer Controller P.C. Board.

     This is the Internal Executive ROM Space.

     LB-3 = position "0" of Tester's Front Panel Program ROMs (User ROMs).

     LB-4 = position "1" of Tester's Front Panel Program ROMs (User ROMs).

2. If a RAM is bad, LA-2 will light up indicating that you have a RAM failure. RAM failures require the Tester operator to help it tell him exactly which part of which RAM has failed.

NOTE: Once you are in a RAM test and have a failure indicated, the Tester **WILL NOT** allow you to exit this mode until the failure is fixed. Then the Tester continues the test to see if there are any more failures in locations following the one you just fixed. If there are, they must be fixed in order.

3. LB-1 through LB-6 are used to indicate any one of 6 types of failures. LB-1 & LB-2 and LB-4 & LB-5 test for address sensitivity in the RAM (typically, this would be addresses that are being written to

that are not being directly addressed). LB-3 and LB-6 are tests that check the actual data stored in each location.

To sum up, LB-1 & LB-2 and LB-4 & LB-5 are complementary address sensitivity tests and LB-3 and LB-6 are complimentary data sensitivity tests.

- ☐ LB-1 and LB-2 tell the operator that the RAM failed in a field preparation test. This means that the RAM has not been able to be cleared and changed to all "1's".
- ☐ LB-3 is a "WALKING BIT" test. The Tester walks a "0" through a field of "1's". This means that somewhere in the RAM there is a "1" that will not change to a "0" when it is told to.
- ☐ LB-4 and LB-5 tell the operator that the RAM failed in a field preparation test. This means that the RAM has not been able to be cleared and changed to all "0's".
- ☐ LB-6 is a "WALKING BIT" test. The Tester walks a "1" through a field of "0's". This means that somewhere in the RAM there is a "0" that will not change to a "1" when it is told to.

4. Next, press Push Button PL1 to increment the test and give the operator more diagnostic informa-

Universal Tester Memory Map

MEMORY LOCATION	DESCRIPTION	TYPE	
0000H 0FFFH	ROM 0 (INTERNAL EXECUTIVE 4K BYTES)	MEM	MEMORY
1000H 1FFFH	ROM 1 (INTERNAL EXECUTIVE 4K BYTES)	MEM	
2000H 2FFFH	ROM 0 (EXTERNAL USER 4K BYTES MAX.)	MEM	
3000H 3FFFH	ROM 1 (EXTERNAL USER 4K BYTES MAX.)	MEM	
4000H 43FFH	RAM 1K BYTES	MEM	
4400H	SWITCHES S-1 — S-8	I	FRONT PANEL
4401H	PUSH BUTTONS PB-1 — PB-8	I	
4402H	PUSH BUTTONS PR-1 — PR-5	I	
4403H	I/O CONTROL PORT 1 (9BH)	0	
4404H	PUSH BUTTONS PL-1 — PL-5	I	
4405H	L.E.D.'s LA-1 — LA-8	0	
4406H	L.E.D.'s LB-1 — LB-8	0	
4407H	I/O CONTROL PORT 2 (90H)	0	INPUT/OUTPUT
4408H	$\overline{\text{BUSREQ}}$	0	EXTERNAL BUS CONTROL
4409H	EXA15	0	
4410H	G.P.I.O. BITS A0 — A7	I/O	GENERAL PURPOSE I/O INTERFACE
4411H	G.P.I.O BITS B0 — B7	I/O	
4412H	G.P.I.O. BITS C0 — C7	I/O	
4413H	G.P.I.O. BITS D0 — D7	I/O	
4415H	I/O, VREF. CONTROLS	0	
4416H	LOAD CONTROL — BITS A0 — A7	0	
4417H	LOAD CONTROL — BITS B0 — B7	0	
44FFH	I/O EXPANSION	I/O	
4500H 7FFFH	INTERNAL MEMORY EXPANSION		EXPANSION
8000H FFFFH	DEVICE UNDER TEST (EXTERNAL MEMORY SPACE)		

tion. The display that will now be shown on the LEDs is the BINARY NUMBER for the exact address of the byte that has failed.

NOTE: A Binary "1" is indicated by a **lit** LED. A Binary "0" is indicated by an **unlit** LED.

This is read as LA-1 through LA-8 being the higher order address byte and LB-1 through LB-8 being the lower order address byte. When reading this number, LA-1 is bit 7 (the **MOST SIGNIFICANT** bit of the byte) and LA-8 is bit 0 (the **LEAST SIGNIFICANT** bit of the byte).

So, say for instance that location 4000-H is failing, what you would see as the address of the failing bit (after you pressed Push Button PL1) is LA-2 lit up and all other LEDs will be OFF.

NOTE: SEE "HOW TO READ LEDS" FOR A DETAILED EXPLANATION OF HOW TO READ THE BINARY NUMBERS OFF THEM, CONVERT THEM TO HEXIDECIMAL, AND THUS FIGURE OUT WHICH RAM TO REPLACE. SEE **MEMORY MAP.** ALSO SEE **"RAM ORGANIZATION"** SECTION.

5. After obtaining the failing address, press Push Button PL1 again and you will be shown the **ACTUAL DATA** and the **EXPECTED DATA.** LA-1 through LA-8 displays the data that should occupy the test address location and LB-1 through LB-8 displays the data that actually occupies the test address location. So you are actually seeing the data that caused the failure.
6. By pressing Push Button PL1 again, the sequence (beginning with the failure I.D., the address, and the actual expected data) will repeat itself for the next failing location. If there are no more failing locations, the LEDs will all go out.

Ram Organization

There are two RAM IC's on the Computer Controller P.C. Board. They are installed in locations A8 and A9 on this P.C. Board.

Each RAM is 1024 Bytes large and is organized 1 NIBBLE (4 Bits) wide. So, each RAM is 1024 x 4. They are said to be "NIBBLE WIDE".

A8 is the **LOW ORDER NIBBLE.**
A9 is the **HIGH ORDER NIBBLE.**

This means that in order to determine which RAM is failing — you **SHOULD NOT** look at the MEMORY ADDRESS. **YOU MUST LOOK AT THE DATA** to see if it is failing in the **HIGH ORDER NIBBLE** or in the **LOW ORDER NIBBLE.**

If the **DATA** is failing in the **LOW ORDER NIBBLE,** then replace A8. And if the **DATA** is failing in the **HIGH ORDER NIBBLE,** then replace A9.

VI. How To Read LEDs

To begin with, we must make a few simple statements and set forth some rules that pertain to the Tester and to the way it catalogs its information.

1. Digital Computers store all the information they have in memory locations specified by addresses. This information takes the form of "0's" and "1's" which are then stored in the above memory locations.
2. The "0's" and "1's" stored within these memory locations are called BITS.
3. Eight BITS make up a BYTE.
4. One half of a BYTE is called a NIBBLE.
   Four BITS make up a NIBBLE.
5. Your Tester has two rows of LEDs and there are 8 LEDs in each row.
   The top row of LEDs is made up of LA-1 through LA-8.
   The second row of LEDs is made up of LB-1 through LB-8.
6. Each row of LEDs is equal to one BYTE.
7. Each LED is equal to one BIT.

Because the Computer in your Tester works with information using the BINARY SYSTEM ("0's" and "1's") and stores information in BITS and BYTES, and the addresses in the Computer circuitry for this information are designated in the HEXADECIMAL SYSTEM, a conversion table is needed to easily enable you to go back and forth between the different SYSTEMS.

CONVERSION TABLE
DECIMAL - TO - BINARY - TO - HEXADECIMAL

	8421	
0	0000	00
1	0001	01
2	0010	02
3	0011	03
4	0100	04
5	0101	05
6	0110	06
7	0111	07
8	1000	08
9	1001	09
10	1010	0A
11	1011	0B
12	1100	0C
13	1101	0D
14	1110	0E
15	1111	0F
16	00010000	10

NOTE: The **"8421"** above the BINARY NUMBERS represent **orders of magnitude.** You add the orders of magnitude to obtain DECIMAL SYSTEM numbers for BINARY SYSTEM numbers.

8421
EXAMPLE: BINARY – 1101 = DECIMAL – 13

You add the orders of magnitude that are over the "1's" and ignore those that are over "0's".

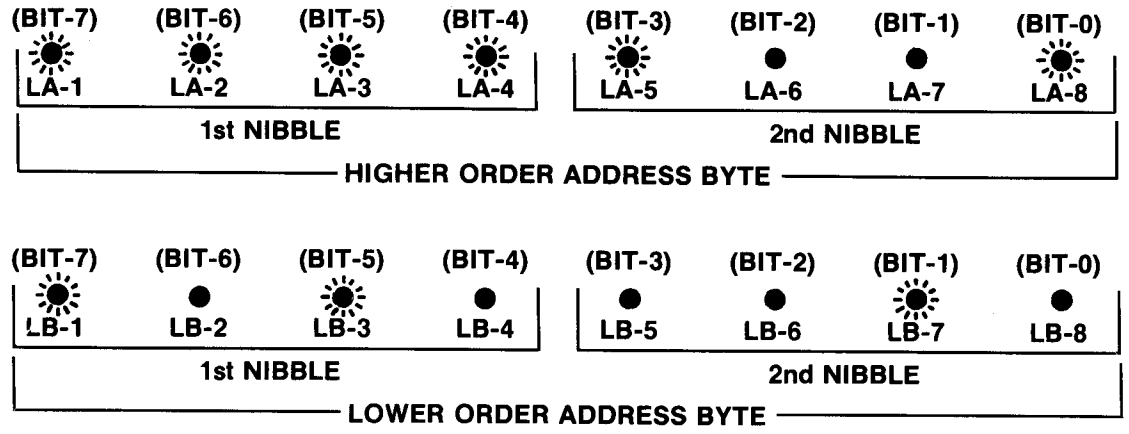
Thus our example can be stated as:

MAGNITUDE **8** + **4** + 0 + **1** = 13 **DECIMAL**
BINARY 1 1 0 1

We have ignored the "2" that was above this BINARY "0".

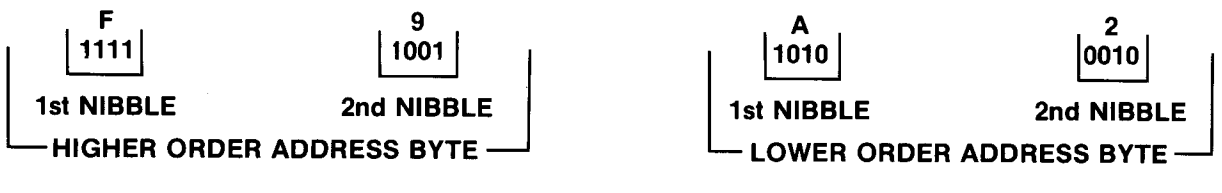
The BINARY numbers in the above table are one NIBBLE wide. And you read each row of LEDs in two NIBBLES. The following table indicates how an address of F9A2 would be read in NIBBLES from the two rows of LEDs on your Tester's Front Panel.

LEDs on Tester's Front Panel



F9A2 is a HEXADECIMAL number. Its BINARY equivalent would look like this: 1111100110100010.

When broken into NIBBLES, this BINARY number equates to:



OPTIONAL/ADDITIONAL EQUIPMENT

At the present there are a number of pieces of optional equipment you may wish to consider obtaining to expand the versatility of **your** Universal Tester. Some of these are:

1.) The digitally Controlled Pot P.C. Board. Some games require the use of a potentiometer (an analog device) to carry out certain functions as opposed to — say — an angle encoder (a digital device). The Digitally controlled Pot P.C. Board allows the Tester to **simulate** the output of this type device.

2.) The Video Interface P.C. Board which allows the connection of a video display to **your** Tester. The addition of this optional P.C. Board will enable the Tester to communicate in written, graphical, or pictorial form with you. It can **LITERALLY** spell out **WHAT** and **WHERE** the problem is.

3.) The MCR II Multiplex Interface P.C. Board which allows the computer in **your** Universal Tester to talk **DIRECTLY** with any one of the 3 P.C. Boards in the MCR II System. These P.C. Boards are 1) the Background/CPU, 2) the Sound I/O, and 3) the Video Generator.

These Interface P.C. Boards will typically relate to a specific GENERIC Family of Game P.C. Boards: MCR III; Vector; Super MCR II; etc.

ITEMS YOU WILL NEED TO TEST A GAME

In order to reduce the need to purchase additional equipment to test new games as they are developed and released for sale, Midway has begun a standardization program pertaining to system hardware for all the games it manufactures. This translates to faster, easier repairs.

When a new game is released, you will need the following items to enable **your** Tester to be connected to and conduct a test of the new game or any of its individual components. You will also be provided with a written procedure explaining how to conduct the tests and defining the functions of things that are not spelled out on the Tester's Front Panel Overlay such as the Joystick functions, how to use the Cabling provided, and how to use the Auxiliary P.C. Boards — if any are included.

1. **GAME ROM** (In the future, more than one game may be placed on each ROM.)
2. **CLEAN VINYL OVERLAY** for the Tester's front panel controls.
3. **INTERCONNECTING CABLE (TESTER-TO-GAME)** (This would **NOT NECESSARILY** have to be purchased to enable you to test each new game as the hardware systems become more and more standardized. One cable may fit many games.)
4. **AUXILIARY POWER SUPPLY P.C. BOARD** (Again, this would **NOT NECESSARILY** have to be purchased to enable you to test each new game. The various voltages needed are pretty well standardized already.)

CONCLUSIONS

1. **Your** Universal Tester is a software programable system.
2. It will **NEVER** become **OBSOLETE.**
3. **Your** Universal Tester **CAN** test not only today's and tomorrow's games, but **YESTERDAY'S** as well.
4. The Universal Tester **CAN** be used in **any ONE** of it's THREE modes; Simulation, Stimulation, and Intelligent Diagnostics — or — they **CAN** be used in conjunction with one another to **GREATLY SPEED** your troubleshooting.
5. A Tester that **CAN** communicate **DIRECTLY** with the computer of **ANY GAME** under test, **CAN** resolve YOUR problems **MUCH** quicker!!
6. **Your** Tester **CAN** check games which incorporate analog devices **AS WELL AS** games which incorporate digital devices.
7. You **CAN** connect a video display to **your** tester so it can communicate diagnostic messages as well as pictorially, or graphically with **YOU.**