SIMM SOCKETS

Consider this scenario: a consumer is contemplating a major purchase, such as an automobile, washer or dryer, home entertainment system, personal computer, etc. After the consumer determines what his/her needs are, the selection process begins. However, with the many manufacturers of these “white” goods available within the market place, the process is, at best, confusing. The consumer is inclined to shop around, ask questions, gather data, examine and evaluate the product and then make the purchase. Engineers often use this same approach when selecting connectors and/or sockets.

The SIMM socket is the latest of the connector products to fall into this category. It is used primarily in computer applications where a single in-line memory module (SIMM*) is mated to the SIMM socket. SIMM sockets are manufactured to meet a number of needs dictated by the user. The SIMM board insertion technique is either a “latch” method or a “plug-in” method (figure 1).

Standard Development

At the forefront of developing industry standards for sockets is the Electronic Industries Association (EIA) Committee on sockets, CE-3.0. This committee, comprised of manufacturers and users of sockets, is currently in the final stages of releasing sectional and detailed specifications for plastic latch type sockets to be used in conjunction with SIMMs. Once released, conformance to these standard places the manufacturers within the National Electronics Components Quality (NECQ) assessment system and also gives the user a valuable means of evaluation.

Latch and Plug-In Sockets

The following socket geometries are generally offered with pin counts that range from 22 to 96 contacts on either 0.050” or 0.100” centers.

- Latch design, single or dual row, vertical orientation,
- Latch design, single or dual row, angled orientation and
- Plug-in design, single or dual row, vertical orientation.

The socket housing is also offered in a variety of materials, such as polyethersulfone, poly cyclohexylene terephthalate and liquid crystal polmer.

The latch technique is a zero insertion force application where the SIMM board is inserted into the socket, then “rolled” until it locks into place via a molded or metal latching system.** This method of engagement causes a wiping action that in essence “cleans” the surface of pads on the SIMM board. The plug-in technique is similar to a card edge connector where the SIMM board is inserted into the socket and locked into place via the contacts. Extraction tools are supplied by the manufacturer to ease SIMM board removal. Standoffs are molded to the sockets, allowing for an efficient means of cleaning that would remove any residue or fluxes most often present following the soldering operation.

A typical contact design utilized for both socket geometries is shown in figure 2. This design incorporates two contacting points per position on the SIMM board. As the pads on both sides of the SIMM are generally interconnected via a plated-through hole, this contact design will allow functionality to be maintained in the event of a single contact element failing. The base material of the contact is typically a copper alloy (e.g., phosphor bronze, etc.) with several contact finishes, such as gold over nickel, tin lead and selective gold.

Critical to the SIMM modules is the integrity of the solder joints attaching the devices to the SIMM board. Upon securing the SIMM to a vertical mounting latch-style socket, a “bow” occurs at the center of the SIMM (figure 3). While this “bow” does not appear to be detrimental to the contact interface, there is a growing concern contingent on the magnitude of the bow, relative to the imposed stresses at the memory device’s solder joints (e.g., microcracking, etc.). It has been observed that the magnitude of this bow varies from manufacturer to manufacturer.

The contact finish, whether used in socket or connector applications, can mean the difference between a reliable interconnect or disaster in the field. If the contacts have a “sharp” or “rough” edge, this could tend to penetrate the surface of the pad, possibly leading to base metal exposure, accelerated oxidation and/or fretting corrosion. Normal force is also a significant contact design consideration. In the “latch” design, the normal force is difficult to accurately predict; because of the angled entry, the normal force is not acting perpendicularly to the contact as in a typical plug-in application. These forces are shown in figure 4.

Monitoring Attributes

SIMM sockets are normally exposed to a variety of environmental and attribute tests to determine their performance characteristics. The (non-functional) mating test boards used are generally in accordance with the appropriate JEDEC specifications with thickness of 0.050” ± 0.003”. The basic procedures and test methodology follow those as described in MIL-Std-1344 and/or EIA 364, with variation in the test severities based on application.

The basic monitoring tests performed on a periodic basis are:

Dielectric withstanding voltage (DWV) and insulation resistance (IR). These are basic tests used to establish the integrity of the plastic housings. Generally the normal requirement levels established are being consistently met.

IR : 5,000 mΩ, initial
1,000 mΩ, after humidity

DWV : 1,000 VAC/0.100” centers
650 VAC/0.50” centers

Both of the above attributes should be performed in an unmated, unmounted condition to avoid the influence of test boards, soldering, etc. This is recommended to assure that sockets themselves are being evaluated.

Low level circuit resistance. This attribute is used to evaluate contact resistance characteristics of the contact systems. The test is performed under conditions where applied voltages and currents do not alter the physical contact interface and will detect oxides and films which degrade electrical stability. This attribute is monitored throughout the test exposures. Electrical stability of the contact system is determined by analysis of the change in resistance occurring. The test parameters use a 100 mA maximum test current and an open circuit voltage of 20 mV (for wire technique).

The electrical stability of the system is the key factor and is determined by comparing the resistance value after a given test exposure to its initial value, prior to any exposure. The difference is the change in resistance, the magnitude of which establishes the stability of the interface being evaluated. The actual resistance values observed vary from manufacturer to manufacturer due to contact design differences, such as material, beam lengths, etc., but are generally less than 20 mΩ. However, the stability should be the deciding factor.

In order to categorize the changes, the following guidelines are used:

a) +5.0 mΩ change:
Stable
b) +5.1 to +10.0 mΩ change:
Stable with minor changes
c) +10.1 to +15.0 mΩ change:
Stable with significant changes
d) +15.1 to +25.0 mΩ change:
Marginal stability in non-benign applications
e) +25.1 to +50.0 mΩ change:
Unstable in non-benign applications
Marginal in benign applications
f) >+50.1 mΩ change:
Unstable

Durability. Durability is performed as a preconditioning sequence prior to any subsequent testing. This is performed to induce wear that may occur under normal service conditions on the contacting surfaces of the socket. The durability levels specified range from one mating cycle upward to 25 mating cycles. A complete cycle of durability is the insertion, locking, unlocking and complete removal of the test board. This preconditioning test has been used in conjunction with environmental exposures since, in many designs, the sheared surface of the material is in fact the contacting element. Contingent on the roughness of this surface in combination with tin-lead finishes used, careful examination is required to assure that the abrasive nature of these surfaces does not result in total disruption of the protective surfaces of the module card, thereby exposing base metal or copper substrate.

Generally, sockets maintain stability up to the levels indicated. The key to this preconditioning is when it is used in combination with environmental exposures. By itself, the change in resistance should not exceed 5.0 mΩ after durability.

Environmental and Mechanical Stress Tests

Cyclic humidity. Cyclic humidity provides a means to evaluate the impact on electrical stability of the contact system when exposed to any environment which may generate thermal/moisture type failure mechanisms, such as:

- Fretting corrosion due to wear resulting from micromotion.   Thermal cycling can induce micromotion between contacting surfaces and humidity accelerates the oxidation process.

- Oxidation of particulates which may have been deposited on or entrapped between the contacting surfaces from the surrounding atmosphere.

  The test severities used will vary contingent on application. These severity levels are most commonly used:

a) Relative humidity: 90 to 95%
b) Temperature conditions: 25 to 65˚C
c) Mating conditions: Mated
d) Mounting conditions: Mounted (for LLCR)
e) Duration: 240 hrs.

Stable low level circuit resistance results were observed on the plug-in type sockets (<+5.0 mΩ maximum change) following cyclic humidity. The change in low level circuit resistance on the latch version, however, has ranged from stable to unstable conditions (<+5.0 mΩ maximum change to >+50.0 mΩ maximum change). The observed changes appear to be interrelated to the surface roughness of the contact interface and the level of durability chosen. This is an area where evaluation is required as the surface conditions vary between manufacturers.

Vibration. Vibration testing will evaluate the sockets to determine if the designs are susceptible to fretting corrosion due to mechanical motion. It will also determine if the electrical stability of the system has degraded when exposed to a vibatory environment and/or if electrical discontinuities at the level specified exist.

Vibration testing should be performed with a “weighted” mating card in order to simulate the mass of the memory chips used in actual field application. The total mass of the memory devices attached to the production SIMM is dependent upon application specified by the user, such as overall size of SIMM, single- or double-sided applications, amount of memory desired and high-or low-density applications.

Once these questions have been resolved, the simulated mass can be determined.

The vibration severity level used is 10-55-10 Hz with a 0.06" double amplitude. Vibration is performed for two hours in each of three axes.

Sockets are normally monitored for a 1.0 µs interruption and meet this requirement through all axes of vibration for both the latch and plug-in variations. At the severity level indicated, the change in low level circuit resistance was less than +10.0 mΩ indicating stability is maintained at these condition.

However, there have been requests to perform higher levels of vibration on both the latch and plug types of sockets. These parameters range from frequency levels of 10-500-10 Hz at 10 Gs to 10-2,000-10 Hz at 15 Gs. Test results at these levels indicate that a degree of instability exists at these levels. Although there were no discontinuities of 1.0 µs or greater on the latch SIMM sockets, the change in low level circuit resistance ranged up to +125.0 mΩ, leaving concerns on the integrity of the contact interface with, in some instances, evidence of fretting corrosion existing.

It was also observed that at these higher vibration levels, the mating board had become dislodged from the socket particularly with the plug-in versions. A vibration scan was performed to determine what peak "G" levels were occurring on the mating board. An input amplitude of 0.06" or 10 Gs produced a peak G level that was in excess of 150 Gs on the mating card. However, it should be noted that at the standard vibration test condition of 10-55-10 Hz, this phenomenon did not exist (normally the socket is fixtured to the vibration table but the module card is left unrestrained).

Mechanical shock. Mechanical shock determines the mechanical and electrical integrity of connectors for use with electronic equipment subjected to shocks such as those expected from handling, transportation, etc. Weighted module cards are also used in this test. The normal shock conditions used are as follows (on the same samples that had vibration performed):

a) Peak value : 50 G
b) Duration : 11 ms
c) Wave form : half-sine
d) Velocity : 11.3 ft/s.
e) Number of shocks : 3 shocks/direction, 3 axes (18 total)

Although the majority of shocks tested were stable under these conditions, a few versions did have high changes in low-level circuit resistance up to +100.0 mΩ. During failure analysis, the daughtercards were unmated from the socket and subsequent visual examination showed no physical abnormalities on the daughtercard or the socket. The daughtercard was remated and low-level circuit resistance was performed once more. The change in low-level circuit resistance dropped to a more stable level that ranged up to +5.0 mΩ.

While it is difficult to determine the specific cause of the high low-level circuit resistance following mechanical shock, it has been our experience that such changes can be a result of micro-scopic debris becoming trapped at the contact interface. This entrapment could have occurred as a result of micromovement during vibration and further micromotion resulting from the shock pulse. As the daughtercard was removed from the socket so could have the debris, resulting in the lower low-level circuit resistance upon remating.

Thermal shock. Thermal shock determines the resistance of a given electrical connector to exposure at extremes of high and low temperatures and the shock of alternate exposures to these extremes, simulating the worst probable conditions of storage, transportation and application. The severity levels are as follows:

a) Number of cycles	:	5 to 25 cycles
b) Hot extreme	:	+85°C (+3°C/-0°C) to +105°C (+3°C/-0°C)
c) Cold extreme	:	-55°C (+0°C/-3°C)
d) Time at Temperature	:	30 minutes
e) Mating conditions	:	Mated
f) Mounting conditions	:	Mounted

Low level circuit resistance performed on mated sockets following thermal shock exposure were categorized stable with minor changes for the latch-type sockets and stable for the plug-in type. This difference between the latch type and plug-in type SIMM sockets is not considered detrimental in the performance of either socket design.

Temperature life. Temperature life will evaluate the impact on electrical stability of the contact system when exposed to a thermal environment which may generate temperature dependent failure mechanisms such as:

- Dry oxidation of base metals and/or underplates which have reached the contacting surfaces by impurity, diffusion or pore corrosion,

- Dry oxidation and/or film formation of particulates which may have been deposited on the contacting surfaces from the surrounding atmosphere,

- Dry oxidation due to smearing of base metal and/or underplates on the contacting surfaces or exposure of same due to wear,

- Reduced normal force due to thermal relaxation and

- Dry oxidation of the contacting surface when non-noble finish systems are utilized.

The temperature levels range from exposure at 85°C up to 105°C with test durations from 96 to 1,000 hours.

The majority of the latch versions remain stable, with a few variations, with changes in low level circuit resistance up to +50.0 mΩ. The plug-in versions remained very stable with changes less than 1.0 mΩ.

Point of contention. Existing documentation requires the same test board be used for durability and remain mated to its socket during all subsequent tests. Very rarely, in field applications, is a SIMM board placed back in its socket following removal. The socket over its lifetime would see a certain amount of durability, but the SIMM board would not. Therefore to simulate field applications, it is recommended that an untested board should be used for any subsequent test environments. In some preliminary evaluations, it has been observed that the unstable conditions during cyclic humidity did not occur when an untested board was used after durability has been performed.

Summary

Table 1 is a generalized summary of the performance potential of SIMM sockets based on the evaluations performed. The observations indicated should be interrelated to key features exhibited by the varied designs. For the latch concepts, the magnitude of the bow can result in additional induced stresses on the surface mount module card devices. The bow can also result in uneven distribution of normal forces, particularly at the end positions. The distribution is dependent and will vary on the detail design consideration used. It is an area worthy of evaluation and test results should dictate acceptability. However, for the plug-in concepts, these concerns do not apply.

The surface condition of the contact area is a concern particularly when durability is a factor. Some of this concern can be alleviated (for testing purposes) if the point of contention mentioned previously is resolved. All SIMM sockets appear to be stable in low vibration conditions only. However, the location in the system may be a cause for analysis due to potential amplification factors.

SIMM sockets, just as any other relatively new interconnection system, possess a series of interrelating factors which must be reviewed in the selection process. As the weakness and strengths are recognized, new variations are generated which result in expanding the field of application and their ability to withstand increasingly severe environments. This has been recognized by the manufacturers and upgraded sockets are evolving addressing these issues.

Some of the information regarding the plug-in socket was obtained by the author from Robert Tondreault, Robinson Nugent, Inc., New Albany, IN.

**SIMM is under patent to Wang Laboratories, Lowell, MA.*
*** Metal latch sockets are under patent to AMP Incorporated, Harrisburg, PA.*

TABLE 1
SIMM Socket Performance Potential

	Latch	Plug-In Design
Durability	Stable	Stable
Cycle Humidity	Stable with minor change	Stable
Cycle Humidity/Durability	Stable to unstable	Stable
Vibration/Shock	Stable †	Stable †
Vibration/Shock/Durability	Stable to marginal †	Stable †
Thermal Shock	Stable	Stable
Thermal Shock/Durability	Stable with minor change	Stable
Temperature Life	Stable	Stable
Temperature Life/Durability	Stable to marginal	Stable

† All SIMM sockets appear to be stable in low vibration conditions only. However, the location of the socket in the system may be a cause for analysis due to potential amplification factors.