COMPETENCE IN MEMORY

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By Memphis Electronic AG

Which one would you prefer to play in the professional league?

What is a “Poor Man’s” Industrial Temperature DRAM Module? Memphis Electronic explains low cost means low quality and poor reliability.

Poor Man´s Industrial Temperature Grade?
Are there poor man’s industrial temperature grade modules? Yes there are! Take any normal DRAM of latest technology, nail it on a module and quickly test those modules at -40C for functionality … some manufacturers use this method to provide poor man’s industrial products! Why do we call them poor man’s modules? … we will explain it after review of 5 Steps Memphis Electronic industrial product manufacturing process:

Step 1 Chip Selection is Key!

Good industrial quality can only be achieved if you start with good quality chip material. An unripe apple will never deliver a good apple pie, no matter how much sugar you add! For industrial product quality it is key to select mature chip technologies with high volume market delivery. All DRAM suppliers struggle to develop cost effective test coverage for their newest technologies. Effective test coverage is accomplished only when high volumes had been delivered into many customer platforms, production yields are high and stable, all the painful test coverage adaptions have been completed from customer complaints, only then can a chip be mature enough to deliver good industrial performance.

➜ Only mature (older!) technologies with high volume application feedback are suitable for industrial applications!

Step 2 Burn-in with elaborate test conditions and long test times!

Burn-in must be executed with original OEM test modes and executed with long test times. Only with OEM test modes to elevate e.g. internal voltages and parallelize stress patterns will effective Burn-in be possible. It is important that Burn-in times need to be long to deliver industrial quality. This is due to the fact some test contents are effectively moved into Burn-in for screening of lot or quality issues … e.g. VRT – variable retention time. All chip suppliers suffer to some degree from instable retention behavior, single cells which change their retention behavior randomly after 1 or 2 hours. How can this be found in a 200 sec Advantest test? If Burn-in takes longer like 8 to 10 hours and such tests are incorporated in Burn-in, this kind of quality defects will be found.

➜ Burn-in must be executed with OEM test modes, run for a long time and incorporate test patterns for VRT and other quality defects with long detection times

Step 3 Component Test Coverage

We mentioned already in Step 1, the chip supplier needs multiple years and high delivery volumes to achieve high test quality, we call this high test coverage. All kinds of technology deviations and functionality exceptions must be covered by the test programs. Industrial temperature grade can only be achieved if this original test program is applied at industrial temperature ranges!

➜ Original high volume mature test program patterns need to be applied at industrial temperature range with longest test time flow

Step 4 Additional Guard Banding

Additional steps can be done to ensure robustness of memory cells beyond the chip suppliers test coverage. This is achieved by more stringent "guard-banding". Methods for additional guard-banding are e.g.: setting of higher retention times, lower voltages, higher/lower test temperatures etc. during test.

➜ Guard banding further eliminates weak memory cells

Step 5 Module Characterization and Application Test

After Steps 1-4 only high quality industrial grade components will end up on the module. This would already deliver high quality modules without further test ... so why do we need extensive module characterization and 100% application test for customers with highest quality requirements? During the module assembly, thermal stress may cause some memory cells to degrade. Also, component testing is done in an ideal tester environment, whereas in real world applications there is power noise and signal coupling concerns which might further weaken memory cells which may have just marginally passed Steps 1-4.

➜ Extensive application testing and characterization ensures there is no quality degradation due to module assembly or cells weakened by signal integrity issues

Rich Man's vs. Poor Man´s Industrial Temperature Grade!

Now we can answer the question we started from, "are there poor man's industrial temperature grade modules?" The 5 Step industrial manufacturing process explained requires effort and some costs. Higher costs include using mature technologies (avoiding using the latest, cheapest and most immature technology), long burn-in and long test times on expensive equipment. In addition, stringent procedures during module testing result in additional yield loss.

Is it possible to achieve similar quality with commercial grade DRAM components on memory modules being tested at -40C? No! If such manufacturers would indeed be able to get access to full test programs and apply similar guard banding at module level testing they would experience 10% yield drop per component, i.e. a module built of 9 components would achieve only a yield of 90% at best!

This is why we call it the poor man's industrial product. It can be realized by lower cost but will not deliver full industrial quality as we achive by our 5 Step flow.

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[3] "Process management for avionics - Electronic components capability in operation - Part 1: Temperature uprating" IEC/TR 62240-1:2013, Apr. 2013. (https://goo.gl/wGJdxa)

[4] Micron Technology, Inc., "TN-00-18: Uprating Semiconductors for High-Temperature Applications," pp. 1–14, May 2008. (https://goo.gl/G3uejd)

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