Micross Components Technical Paper

What is obsolescence ?

***Obsolescence**, noun, going out of use or fashion, becoming obsolete q.v.*
***Obsolete**, adjective, not used any more, (from the Latin obsoletus = worn out)*

Obsolescence, as we use it, refers to components or items that are no longer available. The reason for a component not being available could have many causes; the original manufacturer is no longer in business, the manufacturer can no longer make it, or the manufacturer has no desire to make it.

Obsolescence initially hit the semiconductor industry in the early ‘90’s, and high reliability components, required for military applications, were the first casualty, but as the laws of supply and demand apply to component supply as much as to any other market, other electronic and non-electronic components, destined for different markets, became targets for obsolescence.

How is obsolescence caused, a case in point …

As a society, we enjoy the fruits of modern technology, and always seem willing to buy the latest technological device, be it a new WAP phone, DVD player, faster PC or a more advanced car, but we also shop around for the best price / performance that we can purchase. Most people nowadays would not thank you for a 5-year old PC, based upon a ‘486 processor, let alone a 15-year old PC, based upon the latest ‘286 technology. Neither would they welcome an old “luggable” mobile telephone to replace their lightweight handphone.

Each of these gizmo’s are full of silicon integrated circuits (IC’s), that have to made cheaply enough to satisfy the profit margins required by the device manufacturer and reseller. Would anyone 20 years ago have believed that an IC could be so cheap as to be put into a birthday card or a MacDonalds give-away toy ?

An IC manufacturer has economies of scale to consider. His smallest batch will be around 25 off 150mm wafers, generally yielding a viable silicon area of about 400,000 mm^2 . Given that a silicon area of 2mm^2 gives sizeable functionality and connectivity, the IC manufacturer’s minimum viable quantity here would be about 180,000 working devices (assuming ~90% yield), and most manufacturers don’t want to process just one small batch !

Assuming the purchaser requires just 1000 devices per year as part of his Just-In-Time procurement methodology, the remaining devices must be held somewhere in the supply chain … earning no revenue for the manufacturer or franchised vendor. It is therefore small wonder why the major IC manufacturers prefer to sell into a fast-moving, high volume business, even though the profit margin per part may be significantly less. Some IC manufacturers have stressed the point that they themselves never obsolete a part, it is the lack of sales for that part that causes obsolescence.

These economies of scale, hence issues concerning the viability of manufacture, are present throughout the electronic component manufacturing industry, from IC’s to connectors, capacitors and cables.

So why don't they just make some more ?

As previously stated, the manufacturer may have already ceased trading, but more likely is that it was an old product, made and tested on older machines, that themselves have been rendered obsolete by either lack of spares, or the inability to maintain and repair. This again can be caused either by a fundamental lack of parts, or, more often, a lack of experienced people who know how to fix the machines; some of this equipment can be extremely complex.

Even if the manufacturer can assemble all the appropriate equipment and the engineers with the requisite knowledge, the cost of re-opening a manufacturing line will far outweigh and profit he will make from fabricating a few more parts.

Sometimes the raw material, such as the special mylar films used in the manufacture of capacitors, is just no longer available; or that modern legislation on certain hazardous materials or processes prevents the manufacture.

All IC manufacturers periodically invest in both new and replacement equipment, and with improving processes and decreasing geometry's meaning enhanced functionality, die shrinks are common, and so older, less efficient processes make way for the new. Decreasing geometry's leads to lower voltage breakdowns, so the higher voltage parts, which are selling only in small quantities, will naturally be the first to go. As each new semiconductor foundry appears to cost at least double that of it's predecessor, it's little wonder that the semiconductor manufacturing industry races forward at such a pace, leaving a wide wake of customers faced with supply issues.

How will it affect me ?

Quite often, without a procurement plan that includes planning for obsolescence, the first signs that become apparent to an OEM is that your distributors are unable to supply the desired components on time or at all. If the component has no readily available substitute, and is critical to a particular project … things start getting rather serious.

This can really be a "bolt-out-of-the-blue" if there is no preparation, planning or warning.

If your projects gestation period, from concept design - prototype - acceptance to manufacture is greater than 18 months to 2 years, it is now highly likely that at least 10% of your semiconductor devices will be obsoleted by the IC manufacturer during this timeframe if you have chosen to purchase in the commercial market. It is worth remembering that by purchasing in the commercial marketplace, you are effectively signing-up to the this markets nature, of ever changing products and continuous development, and not one that is nowadays intended for industrial, military or aerospace timescales of evolution.

So what can I do ?

Starting from the beginning, if you are a serious purchaser of components, and by that we mean that you honour your agreements and don't flit from distributor to distributor, you will find that your existing distributors and suppliers will have already been acting on your behalf to help secure your supply chain anyway.

They will probably have received last time buy notices from the device manufacturer, and will have informed your purchasing department of this issue. This still requires you to secure your own supply chain, and maybe you will have to purchase up front your full requirement. This is the downside of just-in-time procurement, that we're no longer used to having to hold vast inventories, and individual companies must make their own decisions. It helps to know about alternative supplies, and to have a list of all the components that you consider (a) critical to your own manufacture, and (b) have no known second source … and this is the beginning of establishing your own obsolescence strategy.

You relationship with your suppliers should be such that you can discuss your concerns, and your own engineering team should also be tasked with considering the various options to reduce or remove this risk. At the end of the day, your obsolescence strategy will act as an insurance for your own ability to manufacture your products.

A word of caution here is necessary. It has been known, albeit rarely, that a semiconductor IC manufacturer does not issue a sufficiently timely last-time buy notification to allow procurers to arrange suitable finance, or more rarely, give no indication whatsoever.

The device really has gone, so what can I do now ?

On the assumption that you knew the device well enough for your designers to have designed it into your product, you may well have a purchase specification for the part. If the part was custom made for you, you will almost certainly have a fair level of documentation on it's function, technology and build status. Well, at least let's hope so … if not, now would be as good a time as any to ensure that you do have it !

You might have had the foresight to have purchased enough devices to satisfy your requirements, but quite often, the unexpected happens and your customer wants more of your product that you hadn't banked on … a high class problem.

There are many approaches to solving obsolescence, and it does depend upon HOW the IC device has gone obsolete, i.e.

- . Is the device still available, but not to the correct specification ?
- . Is the device still available, but not in the right package ?
- . Has the device been "shrunk", with some change to the specification or functionality ?
- . Is the device subject to a last time buy ?, and is so have you missed the deadline ?
- . Is the device not available in packaged form, but still available as wafer ?
- . Is the device not available from the manufacturer, but still exists in the supply chain ?
- . Has the device really vanished from the face of the earth ?

The 3 “F’s” …

Form, Fit and Function replacement

Working on the assumption that the device is really no longer available in the quantities required, the device should be analysed on the basis of Form, Fit and Function replacement.

The Form

This is the package style and footprint that the replacement part must fit into, which should also include the method of assembly and testing.

The Fit

This is the matching of the device specification i.e. “fit for purpose”, to ensure that the replacement device will function and survive in whatever environment the original device was designed and used for. This could be temperature range, humidity, vibration or any other physical property of the original device, including such obscure gotcha’s such as using the same decoupling components etc.

The Function

Functioning and operating under the same electrical conditions and supplies as the original part, such that the new part behaves as the original in the application. That means ensuring that the replacement device does whatever the original did, warts and all. This often means not only mimicking the original device’s function under normal operating conditions, but also includes any aberrations that the original device had, that might have been used by the original designers. This could include such areas as invalid codes in microprocessors, severe input overdriving in linear comparators, or even overflow codes in Analog to Digital converters.

To address the replacement of device no longer available, we, at Micross Components, have coined the phrase “the 5 R’s of replacement”. Repackage, Replace, Re-invent, Refit and Re-design. Each of these stages represent a potential stage in finally re-creating the desired product in suitable quantities, from one off to many tens of thousands.

The 5 "R's" …

Repackage, Replace, Re-invent, Refit and Redesign

Repackage

Calling of from existing die stocks, where they exist, the device can be manufactured and assembled into new packages, and processed in exactly the same way as the original device. This is by far the best solution for meeting device conformity, by requires initial forethought from someone to have initially salted away sufficient die or wafer stocks in the first place. A possible drawback here is that this die inventory needs to be funded up-front, and should the OEM's design change such that these parts are not required, the inventory is effectively scrap material, unless someone else can be found to purchase it. Whilst currently there appears to be little problems associated with obtaining old package styles, this will shortly be no longer true … packages such as TO-5 metal canning are becoming scarcer, and the plethora of new package styles, such as micro-BGA, will mean that some package footprints, especially where the pin-count rises above 200 pins, will no longer be readily available.

Replace.

Often the device or product still exists within the market, but not to the specification or package required. This is very typical of military product, where frustratingly the commercial or industrial product is still available. In these circumstances it may be possible to up-screen the current device in accordance with the original specification. In addition, if the die is available, then repackaging into the desired package may also be feasible. Where the die is not economically available, sometimes the use of a dielectric interposer, such as a small PCB, may be used to effect a change in device footprint, emulating the desired package.

When replacing an old ceramic military part with the newest plastic commercial part, it should be borne in mind that the commercial rules that once applied to the military part no longer apply …by purchasing commercial parts, you are accepting the "T's & C's" of the commercial world, and all that goes with it : Die's may shrink, changing certain electrical characteristics, package styles go obsolete, device foundries may change, longevity of product supply is questionable, quality of product often an unknown quantity and design rules not necessarily established for long-term product reliability. To assume that the commercial part is being made on the same line as the original military part is highly erroneous, modern manufacturers now subcontract out much of their fabrication to other plants, many in the Far East, who have never ever fabricated a military product.

Reusing used components may also be feasible, but often there is only a limited number of devices available … which may now suffer from poor yield and uncertain reliability.

Re-Invent

This is where we can get smart with substrates, sometimes necessitating the build of a multi-chip module (MCM) to perform the desired task. The ability to add additional passive components as well as semiconductor die, and to offer various repackaging and re-wiring options can often make this an attractive solution for small to medium volume manufacture. Initial tooling can be costly, especially where a unique ceramic package is required, but use of different PCB materials can be considered where the application permits.

Additional functionality and test facilities can be included at little extra cost, and MCM techniques are well understood.

Refit

Using programmable logic, many digital devices can be simply duplicated, and this technique can be both cost effective and has a very high success rate when intelligently selected. When replacing older PLD's with newer generation devices, the main problems stem from timing related issues, where the new devices are too fast for the original application … often showing weaknesses in poorly specified designs.

The penalty for using this method of device replacement is generally that whilst the function can be accurately replicated, the timing parametrics can't always be made to match (the PLD often being too slow), and the analog parameters will most certainly not conform to the original specification. The use of this option therefore depends upon the flexibility of the OEM, and his resistance to the "threshold of pain" that necessarily comes with PLD type solutions.

Many of the more complex PLD's and PLA's etc., require additional device pins, for either one-time programming, or power-up initialisation. This generally means that addition contacts need to be made, and a custom designed interposer fabricated to facilitate the pin-out of the original device, plus any of the additional pins, as it is almost certain that the PLD pinout or package style won't match that of the original device.

Redesign

This is essentially the ASIC option, where a replacement device is completely re-designed using ASIC technology. This can be an expensive option, but not as expensive as many myths would have it. Dependant upon the existing data of the original part, the re-design can either be very straightforward, where the design data exists in a computer sensible format, such as VHDL or Verilog for a digital part, or completely horrendous, where no viable data exists at all ! Mimicking and redesigning a standard product is generally simple, albeit time-consuming , so long as care is taken during the design to identify and rectify known gotcha's of the original part. A good maxim for redesign is that project success is directly proportional to the quality of data (GIGO: garbage in, garbage out).

Some old generation parts were fabricated on process technologies that are themselves either scarce or unavailable: HV metal gate CMOS and HV Bipolar processes are a case in point, and often, even if the ideal transfer process can be found, the commercial access to the foundry can be prohibitive if only a small quantity is required. Good design houses act as the interface between the customer and the foundry, maintaining good commercial and technical contacts with both.

For redesign of a purely digital device, data on I/O parameters, timing and functionality is generally sufficient information for reasonable success, but a mixed-signal or analog device will normally require additional information, such as full schematics, die layout, transistor sizes etc., for a successful project. ASIC redesign can generally match the pin-out identically, but there may be some constraints on application related issues, such as power-supply, decoupling etc.,

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