Custom Module Capabilities

Introduction

Cypress's Multichip Products group is a leading supplier of custom memory and/or logic modules. This turnkey capability provides designers with a fast, low-risk solution for when they require the ultimate in system performance and density. Detailed information on standard modules can be found in the Static RAM and Module sections of this book.

Packaging Guidelines

High-density memory modules are now available in a wide variety of package styles that satisfy a variety of needs for high-performance system design. Since board space is a primary concern, the choice of a package style is important in meeting layout constraints as well as thermal and mechanical design objectives.

Multichip Products currently supports several commonly used module technologies including plastic components on FR4 or polyimide substrate, and ceramic components mounted on ceramic substrates. Advanced technologies suitable for the demands of higher integration components are also available.

The plastic technology employs plastic encapsulated, surface-mount components and an epoxy laminate (FR4 or polyimide) substrate. The plastic components can be SOJ, SOIC, VSOP, TSOP, QFP, or other surface-mount packages. Die can also be mounted directly to the substrate and wire bonded to the substrate.

The ceramic technology employs hermetic, ceramic-packaged devices mounted on a ceramic substrate. The components are typically leadless chip carriers, but may include other package types. The ceramic substrate has a custom interconnect for the particular components it carries. The ceramic substrate and components offer improved thermal characteristics over the plastic modules. This makes these modules suitable for extended temperature range operation, such as in military applications.

Common Packaging Options

This section describes several common module packaging options available from Cypress. A summary table (*Table 1*) compares relative board areas of each option based on a module with eight 28-pin components.

SIP

The single in-line pin package, or SIP, is a vertically mounted module with a single row of pins along one edge for through-hole mounting. The SIP configuration is typically constructed with plastic-encapsulated components mounted on an FR4 or polyimide substrate, although ceramic SIPs are also used. The pins are on a 100-mil pitch. The vertical orientation and the mounting of components on both sides of the module can increase the component density by a factor of four or more.

Flat SIP

The flat single in-line pin package, or FSIP, is virtually identical to the SIP except that the substrate is mounted in the horizontal rather than the vertical direction. When mounted to a circuit board, the flat SIP lies close and parallel to the board. Flat SIP modules save board area since they, like other modules, employ fine lead pitch surface-mount components on a high-density substrate. The flat SIP density approximates double-sided surface-mounted boards with the advantage of a very low profile and improved mechanical stability over the vertical SIP.

ZIP

The zigzag in-line pin package, or ZIP, is vertically mounted and is usually built with plastic encapsulated components on an FR4 or polyimide substrate. The ZIP module has pins along both sides of the substrate and the pins on alternate sides are staggered by 50 mils. Adjacent pins on the same side of the substrate are separated by 100 mils. The dual row of staggered pins allows a higher connection density than that of the SIP while maintaining 100-mil minimum spacing between any adjacent pins. The ZIP is especially useful in large pin count devices where the host board is designed with through-hole design rules.

SIMM

The single in-line memory module, or SIMM, is similar to the ZIP except that there are no pins for through-hole mounting. Instead, the bottom edge of the module is equipped with edge connector contacts that are plated to the substrate. The SIMM is designed to plug into motherboard sockets. The contacts are on both sides of the substrate, and contacts directly opposite each other are connected together. SIMM edge connector contacts are on a 50-mil or 100-mil pitch. SIMMs allow greater system functionality and flexibility by allowing easy use of multiple densities and speed grades.

Some module devices are available in both ZIP and SIMM packages with the same form factor. The pin out is designed so that the pinout and footprint of the SIMM socket matches the footprint of the ZIP module allowing ZIPs or SIMMs to be used interchangeably with only one board layout. The SIMM may be used in prototyping to test different speed versions of a system and then replaced with a companion ZIP for production, or SIMMs may be used in production for flexibility in memory size or memory speed.

VDIP

The VDIP, or vertical dual in-line pin package, is a vertically mounted module with two rows of pins on 100-mil centers. Row to row spacing is 100 mils, with pins of the two rows aligned directly across from one another. The dual row of pins allows a higher connection density than that of the SIP while maintaining 100-mil minimum spacing between any adjacent pins. VDIP may be either plastic or ceramic. The VDIP is useful in large pin count devices where the host board is designed with through-hole design rules.

DIP

The DIP, or dual in-line pin module, is a low-profile package with excellent mechanical ruggedness. The ceramic DIP is ideally suited for military applications. Plastic DIPs are often used when a low vertical profile is required. In some cases, the DIP device is intended to have an identical footprint and similar form factor to standard integrated circuit components and can provide larger memory capacity in the same footprint.

PGA

The PGA, or pin grid array, has an array of pins that are perpendicular to the package plane. These pins are arranged in a matrix on a 100-mil grid. Most of the matrix is filled with pins except for a central square that is normally devoid of pins.

QUIP

The QUIP, or quad in-line pin package, is very similar to the DIP package except that there is a dual row of pins along the package edge. In-row and row-to-row pin spacing is 100 mils with pins in adjacent rows aligned directly across form one another. The QUIP is a low-profile package with excellent mechanical ruggedness, with the added advantage of higher pin density for the same package length.

QFP

The QFP, or quad flat pack, is a surface-mounted module. Gull wing pins extend out from the square package on all four sides and are formed to be coplanar with the package bottom. Lead pitches are typically 50 mils or smaller.

Package Summary

Table 1 summarizes the various characteristics of the packages discussed above.

Table 1. Package Types

Package Type	Typical Pin Count		Typical Height[1]		Mil[2]	Advantages	Disadvantages	Board Space (sq. in.)[3]	
	Min.	Max.	Min.	Max.				FR4	Cer
SIP	24	50	0.5	0.9	N	Vertical orientation. FR4 or ceramic technology.	Limited pin count.	1.2	0.9
FSIP	24	50	0.2	0.4	N	Very low profile. Mechanical stability. FR4 or ceramic technology.	Lower density due to horizontal orientation.	2.7	2.4
ZIP	24	100	0.5	0.9	N	Vertical orientation. JEDEC-standard pinouts. Pinout compatible with SIMM.		1.2	N/A
SIMM	24	100	0.5	0.9	N	Vertical orientation. Socket mounting. Pinout compatible with ZIP.		1.2	N/A
VDIP	36	104	0.5	0.95	Y	Vertical orientation.		1.2	0.9
DIP	24	60	0.17	0.37	Y	Low profile. Excellent mechanical ruggedness.	Horizontal orientation.	2.9	2.9
QUIP	48	200			Y	Low profile. Excellent mechanical ruggedness. Increased number of pins.	Horizontal orientation.	2.9	2.9
QFP	68	144			Y	Surface mount. Low profile. Excellent mechanical ruggedness. Large number of pins in small area.	Surface-mount technology required. Horizontal orientation. Components on one side only.	3.1	3.1
PGA	68	144			Y	Large number of pins in thru-hole technology. Low profile. Excellent mechanical ruggedness.	Multilayer boards. Horizontal orientation. Components on one side only.	2.9	2.9

Notes:
1. Minimum and maximum height are given in inches.
2. The Mil entry contains a Y(es) or N(o) indicating if the package type is suitable for military applications.
3. Board space roughly quantifies the main board area, in square inches, taken up by the module when the module contains eight, 28-pin components.

Component Selection

Cypress's Multichip Products group handles many types of components to build custom modules. Typically, any digital component that is available in surface-mount packaging can be used, but the module is not limited to this. Standard and custom modules include SRAM, FIFOs, dual ports, EPROM, Flash, and E2PROM devices, combined or mixed. Logic may also be employed to provide decoding, pipelined storage, or extra drive capability.

ECL is also a logic family suitable for collecting into a module. Unless the system is largely ECL, it makes sense to place the ECL components onto a module that is optimized for performance. Delivered as a tested component, the ECL module can be assembled into the system with high confidence of proper functionality. Typical examples of custom ECL modules include wide ECL-to-TTL translators and deep and/or wide ECL PROM or RAM memory arrays.

More complex functions may also be integrated onto a custom module; e.g., processor subsystems, embedded within a system that are dedicated to specific functions. These functions may include several forms of memory, a microprocessor or DSP, communication ports, and bus interface circuitry with possibly shared memory control. A custom module may also include an ASIC designed especially to implement the desired function.

Modules undergo complete characterization and qualification before being released to production. Characterization includes the following: AC and DC characterization over voltage and temperature, and complete custom specification review. Release to production requires a verified test program with test hardware and correlation samples, complete assembly drawings and approved parts list, production and test travelers, a formal design review, and customer approval. In production, custom (and standard) modules are built using fully tested components, and are rigorously tested before they are shipped. As an example of the rigorous production testing, memory modules are tested for all DC parametrics, all AC parametrics, and functionality. Functional testing includes a select set of memory pattern sensitivity tests. This complete testing allows the module to be treated by the user as a true component with a set of specifications that are guaranteed by the manufacturer. This saves time and effort during system manufacture and provides a degree of reliability not obtainable from operations focused on only assembly.

Future Technologies

The ultimate in multichip technology is multiple die on a substrate that offers highly efficient interconnect and the densest multichip assembly technology. The technology is available now for multichip configurations with silicon chips on ceramic, epoxy laminate, and silicon substrates.

Introduction to Modules for the New User

The use of modules is growing rapidly since it is a vehicle for obtaining high integration and high performance with minimal impact on cost. Almost every personal computer now has main memory as plug in SIMM packages constructed from surface-mount DRAM components. High-performance RISC and CISC CPU subsystems are available as modules where the supplier has optimized the component I/O design and the substrate layout for maximum performance amongst the tightly coupled components.

Size is one obvious advantage of modules; their small size allows a function to fit into a very small space. Consider the economics of having a large memory array together with the system CPU on a single card in contrast to the cost of multiple memory cards connected via a backplane bus and the resulting performance loss. In many cases, the module approach is a considerable savings in materials and manufacturing cost by reducing the total number of system cards.

Applying the tight design rules of modules has its limitations. A module has line widths and spacings that support close packing of VSOP and die components, and these spacing/width design rules are at the limit of what can be handled by capable volume production substrate producers. The use of fully tested modules gives the density gain of tight design rules at economically attractive system manufacturing yields. Therefore in the manufacturing process, the module exhibits the characteristics of a monolithic device: high integration, ease of application, and high system manufacturing yield. The module brings high-density surface-mount technology to the through-hole manufacturing environment.

Performance is another significant gain obtainable from module application. Unfortunately this is the most difficult gain to quantify. Consider a memory subsystem collected tightly around a CPU versus the same memory capacity spread over one or more boards. It seems intuitively plausible that the larger subsystem will be slower: the distance to travel is longer, and the memory address and data bus lines have larger capacitance due to their longer length and the larger number of stubs on the lines. This is indeed the case. Many of the custom modules include buffers for reduced loading, registers for data pipelining, and simple or specialized decoders to ease system bus interfacing. Taken as a component, these modules typically exhibit higher capacitance than a monolithic component and incur about 5 ns additional delay for on board decoders or buffers. However, the module is from four to sixteen times as dense as through-hole monolithic devices and consequently achieve a net performance advantage.

Custom Module Development Flow

Multichip's focus is on providing turnkey memory modules. *Figure 1* illustrates the tasks performed during the development of the module.

Module development commences with the generation of a detailed Objective Specification. The module is designed to this specification, and once in production it will be guaranteed to perform as indicated in the Objective Specification.

Components are selected while the specification is being generated. In many cases, the spec is designed such that multiple sources of components can be utilized. Once the spec is complete and the components are selected, a schematic for the module is generated. The netlist from the schematic is used to drive the circuit simulator.

During simulation, several types of analyses are performed. A function simulation is used to ensure that the module's logic is de-signed properly. Timing simulation is run to verify that the module will function when subjected to the worst-case timing delays of the components. Finally, thermal analysis may be performed to determine the thermal characteristics of the module.

The layout of the module is also netlist driven. An autorouter may be used, depending on the complexity and density of the module. Design rule checks are run to ensure that the layout does not violate any electrical or mechanical design rules. Finally, the layout output is used to generate the module substrate.

The layout output is also used to drive the pick and place equipment. This ensures consistency between design and manufacturing. While the module prototypes are being assembled, the test program is generated and the test fixture is constructed. Test program generation is largely automated, using as inputs the simulation outputs and pre-defined test program subroutines for common configurations.

Once prototypes have been generated, the standard release procedure is initiated. This procedure includes steps such as bench testing, module characterization and qualification, and fine tuning of the test program. Following customer approval of the module, it is released to production.

Quoting Information

In order to prepare a quotation or proposal, we need as much as possible of the following information:

- Circuit schematic
- Functional description
- Mechanical dimensions required
- Speed and power requirements
- Prototype and production deadlines
- Production quantity estimates
- An engineering contact to answer questions

Once the above information is received, a budgetary quotation will typically be provided within one to two weeks.

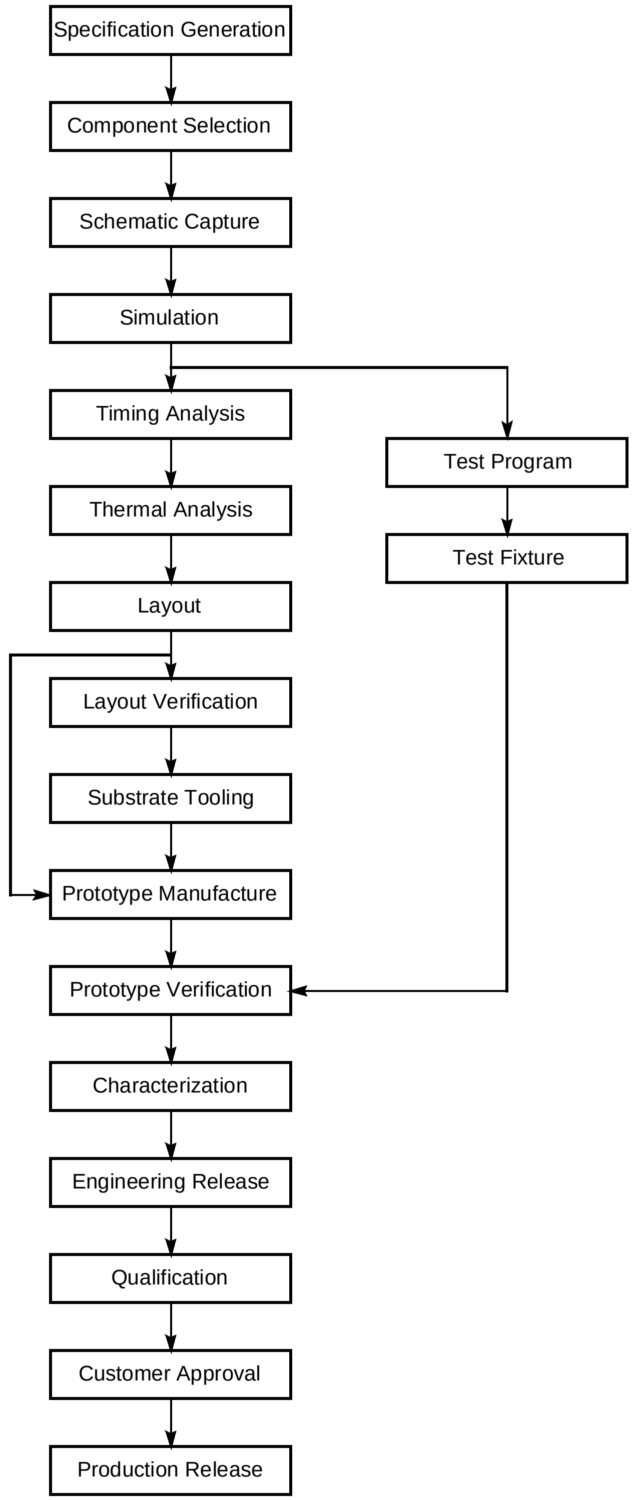

Figure 1. Custom Module Flow