

Introduction To Die & Wafer Products

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Small Solutions for the Information Age

The Information Age is creating a demand for new portable equipment with ever increasing requirements for getting more out of less. This has resulted in a huge growth in the demand for die. The Die Products Business Unit, part of the Hi Rel Operations of TI Semiconductor, is a central, dedicated group responsible for supporting all aspects of TI's die and wafer business.

Die Products and Technology

Designers of space-constrained systems face the challenge of determining how to incorporate expanding functional needs into reduced spaces in a timely and cost-effective manner. For many handheld, portable, and other small form factor products, silicon packaging has become the major size-limiting element of their design layout. The conversion from standard semiconductor packaging to unpackaged die provides the system designer with opportunities for more efficient use of limited space. At the same time, bare die implementation affords improved electrical performance, better signal integrity, and higher levels of integration with reduced weight and height. These benefits allow designers to overcome the challenges of small form factor applications.

TI provides bare die products that can be used in wire bond applications.

The implementation in die form of a standard dual PLL can reduce space consumption by greater than 50%.

The implementation rate of die products is rapidly increasing as a result of both application form factor needs and system performance improvement requirements. The main customer application drivers in the migration from packaged semiconductor die to wire bond die include:

- **Electrical performance**

The lower inductance and capacitance of bare die is important in analog, RF, and power applications. Signal propagation and power/ground distributions are also improved.

- **Size and weight**

Improvements vary based on the current packaging in use.

- **Reliability**

The reduced number of interconnects with die use leads to improved reliability. The typical packaged part has three connection points per I/O. Compare this with only two for wire bonds.

- **Lower cost of ownership**

This is most notable in high volume applications where density is required and high yield silicon is implemented. The lower cost of ownership takes into consideration substrate, assembly, system test, equipment utilization, rework, and increased product value. In addition, the cost of a die product is typically lower than the package equivalent.

These die advantages promote higher levels of integration using existing mature products, lead to increased functionality per square area, and reduce costs. Additionally, performance improvements are achieved with no additional cost penalty. Integrating die for SiP (System-in-Package) solutions provides a benefit over both standard package solutions and SOC (System-on-Chip) solutions. As design cycle time requirements continue to shorten and product time to market becomes increasingly important, die for SiP solutions finds greater utility in meeting the designer's needs.

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TI's Die Product Offerings

A majority of TI's standard products are available as Die Products. Die Products are categorized into two levels of quality assurance.

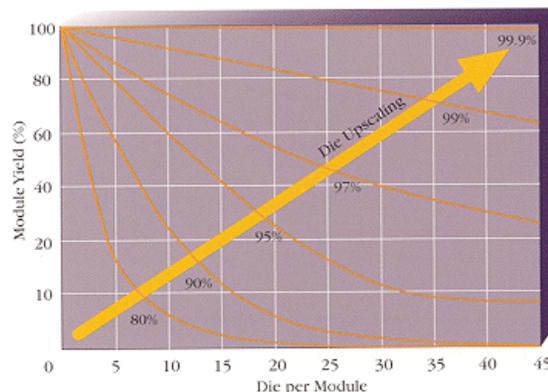
The first category is identified and ordered by the suffix identifiers MDA (die) and MWA (wafer). MDA and MWA Die Products are fully compliant and warranted to the standard package product electrical specifications and reliability levels.

The second quality category is identified and ordered by the suffix identifiers MDC (die) and MWC (wafer). The reliability of these Die Products is equivalent to MDA and MWA. Due to restrictions in die level processing, however, MDC and MWC electrical specifications may not be equivalent to standard-packaged products and are therefore offered with a conditional performance guarantee. Assembly yields are typically 95% or greater, and characterization by the user in the intended application is recommended. All of TI's Die Products are 100% tested at the wafer level and are manufactured using established, mature, stable, and well characterized processes. This insures that MDC and MWC products are reliable and suitable for a wide variety of applications.

The key factors in the choice between bare die and tested die include the number of die in the application, the expected bare die yield, and the customer's ability to rework his module or board.

The graph above shows the trade-off a manufacturer must make. As the number of die in a module or circuit board increases (x-axis), the first-pass yield for that design (y-axis) drops exponentially. Designs with large numbers of die require the customer to balance cost of reworking defective modules against the higher initial cost and availability of known good die. As the number of die in a design increase, the case for using KGD becomes stronger. With less complex designs it may be more cost effective to scrap the small number of defective units, but this will depend on other

Module Yield versus Device Quality



factors, such as the cost of the substrate and efficiency of the rework process.

The average yield curves above are influenced by numerous factors, including the technology being used, the maturity of the die designs, and the stability of the manufacturing process.

For these reason we like to work with our customers to find the best solutions for their unique designs.

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Die Attach - Assembly Options

Traditionally, TI's Die Products have been designed with a peripheral bond pad configuration. This layout style provides easy access for wire bonding of the die to the substrate and is the preferred configuration for COB assemblies. The bond pad pitch and distance between bond pads can vary from Die Product to Die Product in the peripheral configuration.

The bond pad pitch on the peripheral layout is determined based on the optimum die area required for the function, the number of I/O pads needed to access the functions through external connections, and the ability of wire bond equipment to make reliable, efficient bonds.

Our bond pad metallurgy can be used for ball bonding and wedge bonding with gold (Au) or aluminum (Al) wire. Consideration should be given to each process parameter and method, then matched to the application requirements and manufacturing approach.

For more information on die assembly techniques, please refer to our [Application notes](#).

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