

## Introduction To Die & Wafer Products

### Contents

- Introduction
- Die Products and Technology
- TI's Die Product Offerings
- Die Attach - Assembly Options

### 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.

[Go to Top](#)

### 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.

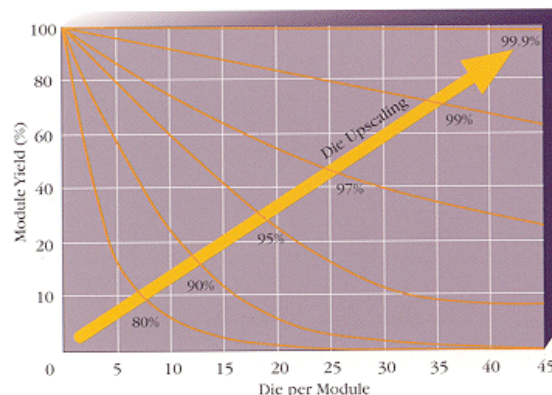
The first category is identified and ordered by the suffix identifiers MDA (die) and MWA (wafer). MDA and MWA Die Products are fully compliant and warranted to the standard package product electrical specifications and reliability levels.

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.

[Go to Top](#)

## 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](#).

[Go to Top](#)

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)