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DECA

QFN Reimagined: Molded Fan-out Panel Solutions for Cost Efficiency and Scalability

Chevie Castillo– Solutions Architect
Robin Davis – Senior Director of Business Development

March 4th, 2025

Outline

- Background
- Leadframe-based QFN
- M-Series Direct QFN (MDQFN™)
- Comparison of Technologies
- Manufacturing Format
- Conclusion

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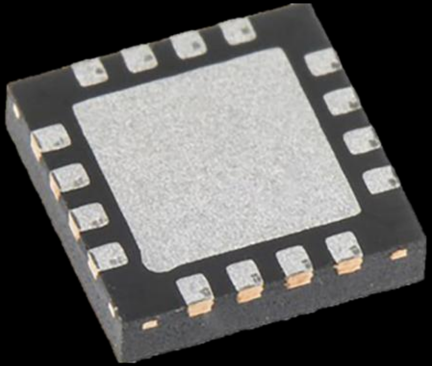
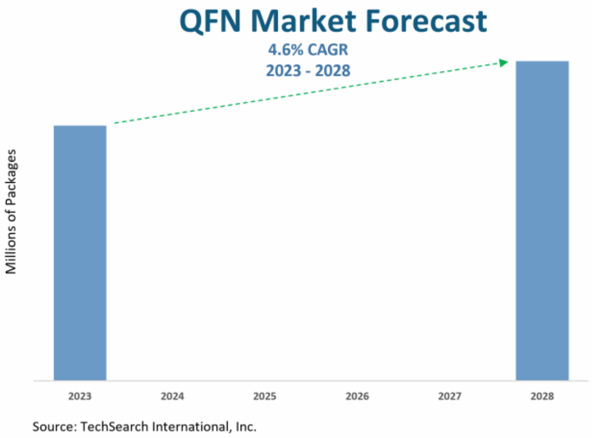
Background

- Found in automotive, networking, and communications—especially wireless, tablets, PCs, industrial, wearables, mobile phones, and servers
- Increased use for power devices
- Low-cost package





Source: TechSearch International, Inc.

‘Leadframe QFN is the “work horse” of the industry and continuing to grow...’

Jan Vardaman - TechSearch International, Inc.

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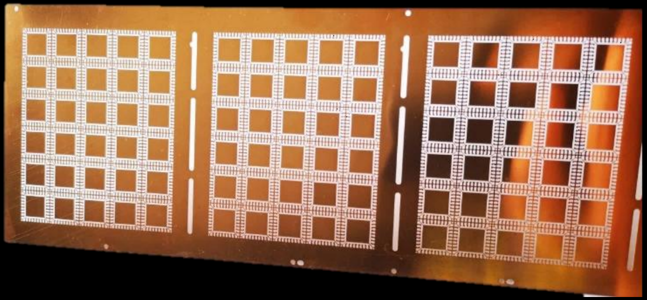
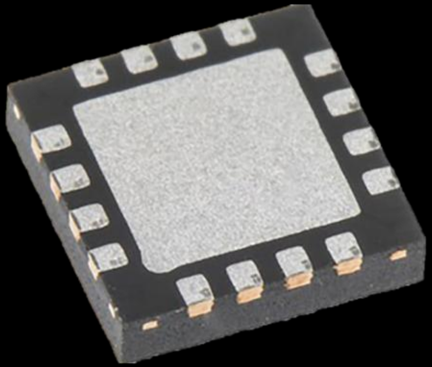
Leadframe-based QFN

Leadframes:



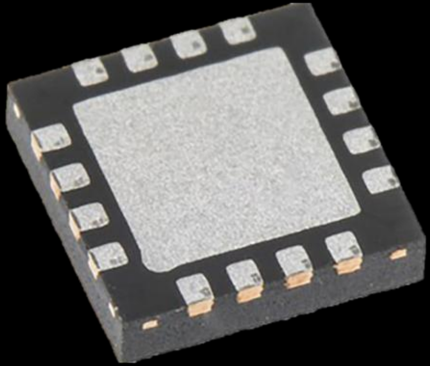


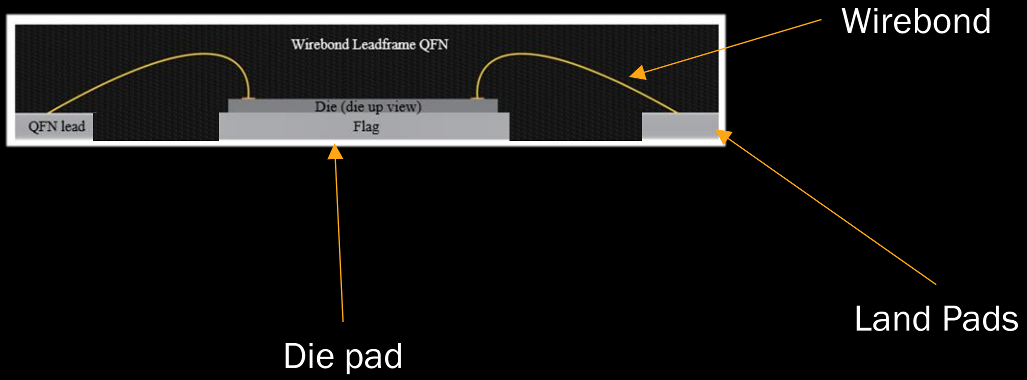
- Typical range of strip sizes for QFN:
  - 75mm × 250mm to 100mm × 300mm
- Many custom leadframes for different devices
- Requires inventory management

SOURCE: https://www.rfidtagworld.com/news/RFID-News/XMINNNOV-developed-IC-package-lead-frames.html

Leadframe-based QFN

Features:





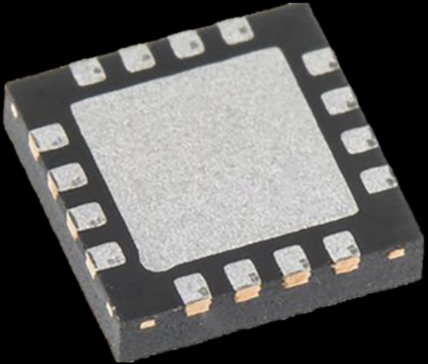
Wirebond

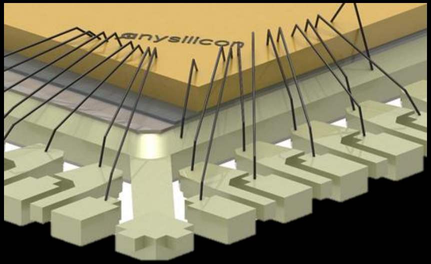
Land Pads

Die pad

Leadframe-based QFN

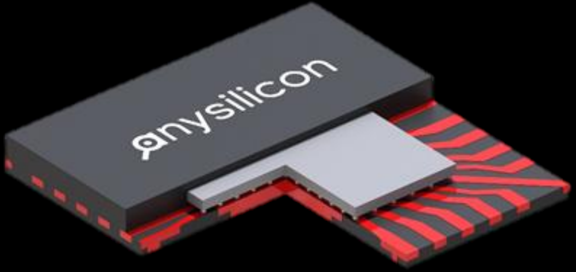
Interconnects:





Wirebond

Conventional method



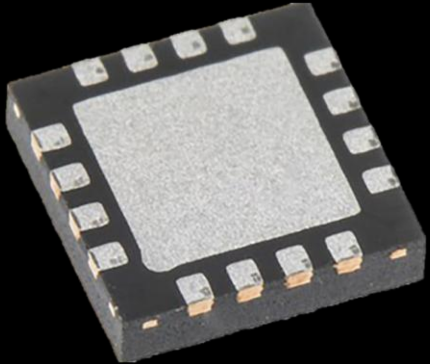
Flip-chip

Advantages in electrical performance and miniaturization

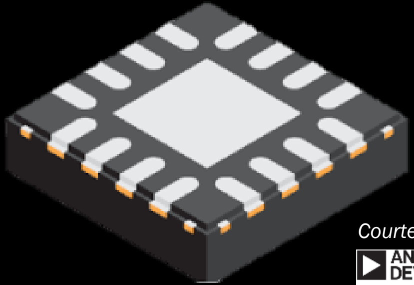
SOURCE: https://anysilicon.com/ultimate-guide-qfn-package/

Leadframe-based QFN

Reliability Challenges:



Standard process not suitable for high reliability applications (automotive)

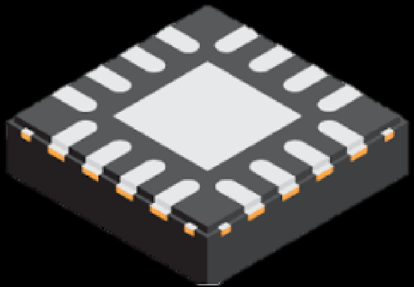


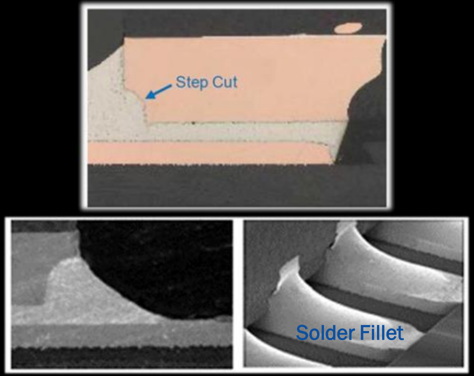
Courtesy of ANALOG DEVICES AHEAD OF WHAT'S POSSIBLE™

Wettable Flank enables optical inspection of solder joint to ensure reliability

Leadframe-based QFN

Wettable Flanks:





Courtesy of Amkor

- step cut before Sn plating to create solder fillet
- automated visual inspection (AVI) compatibility
- improved solder joint reliability

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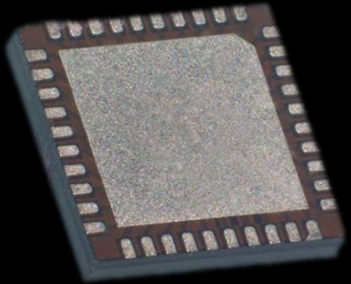
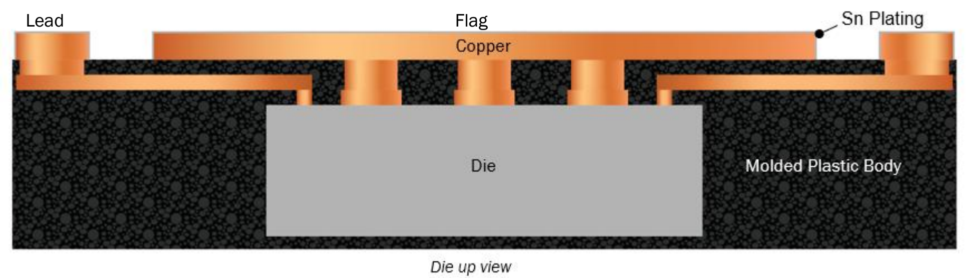
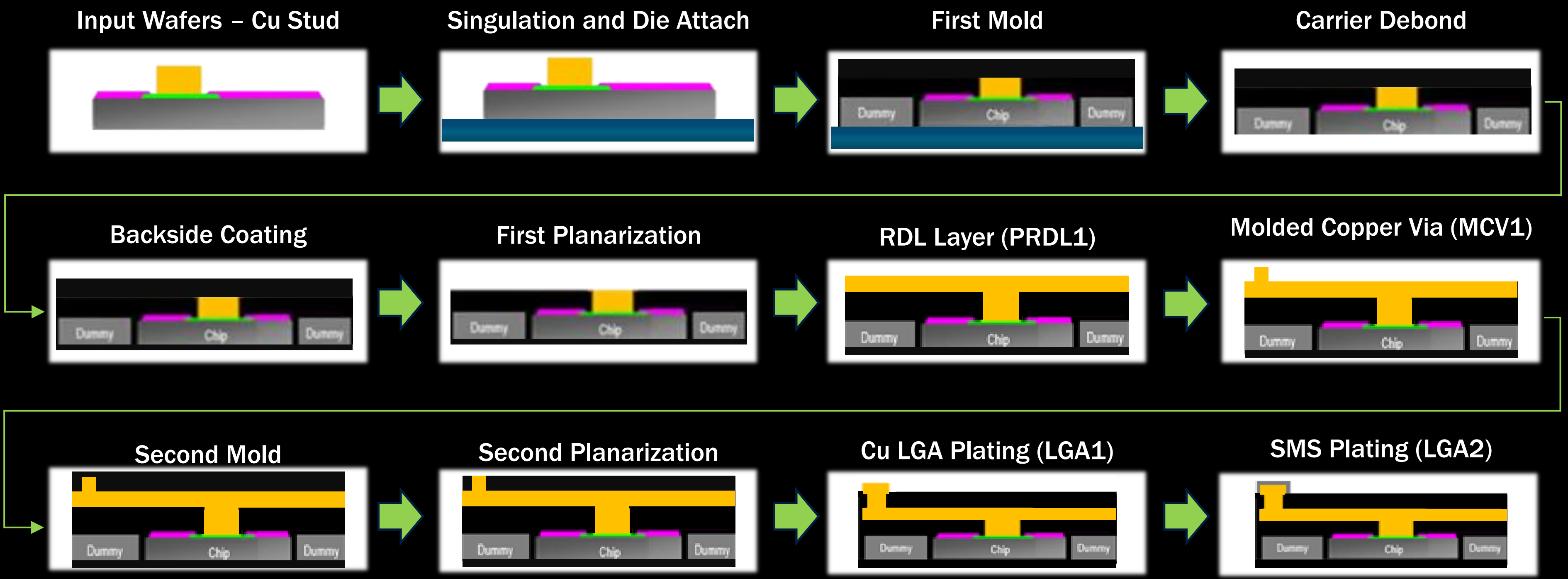
M-Series Direct QFN (MDQFN)





Chips first fan out built on a panel

MDQFN Process Flow


Input Wafers – Cu Stud

Singulation and Die Attach

First Mold

Carrier Debond

Backside Coating

First Planarization

RDL Layer (PRDL1)

Molded Copper Via (MCV1)

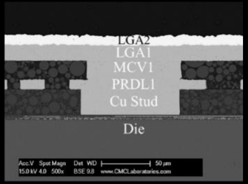
Second Mold

Second Planarization

Cu LGA Plating (LGA1)

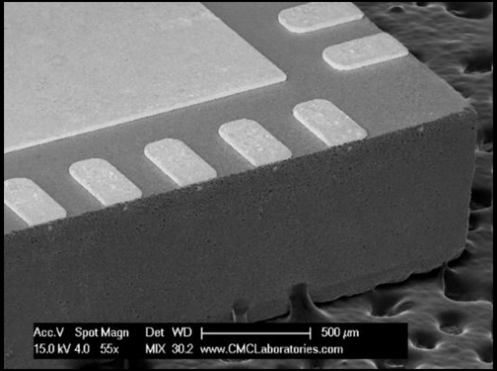
SMS Plating (LGA2)

Final Singulation

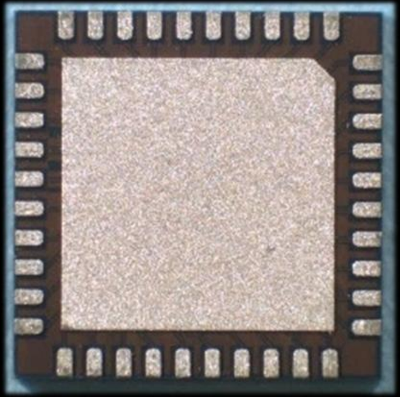


MDQFN Attributes

- 100% JEDEC QFN Compatible - No leadframes or custom materials required
- Wettable flanks on all sides on each land pad and flag
- No isolation cut required for strip test
- Uses new MDx™ (M-Series Direct) process with double molding
- MDQFN has passed reliability of MSL1, 168 hours of uHAST, and 1000 cycles of TCT



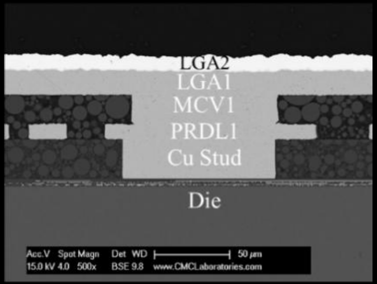
Isometric view of MDQFN Package



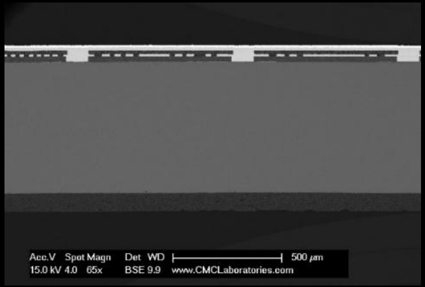
MDQFN Footprint

Note: Multiple patents issued & pending

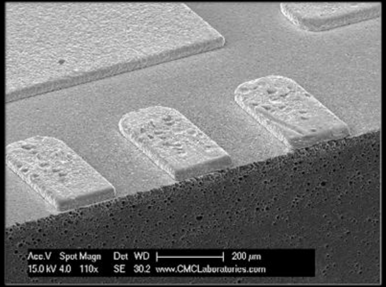
MDQFN Features



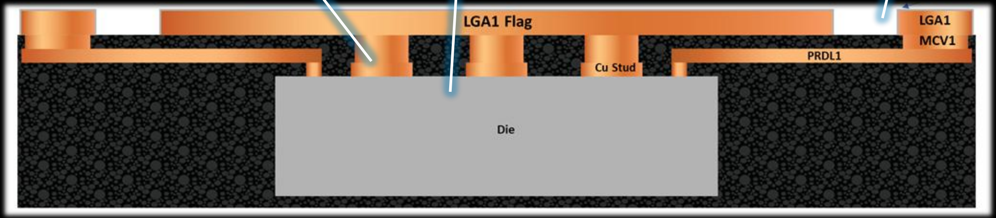
Full stack from Cu stud to LGA2



Expanded view of full stack

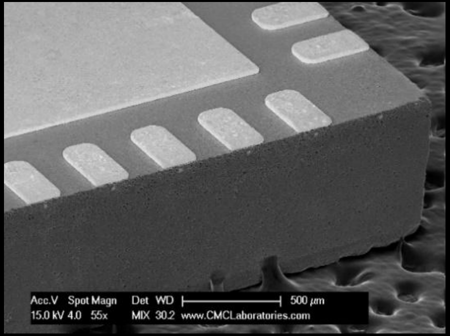


Wettable flank

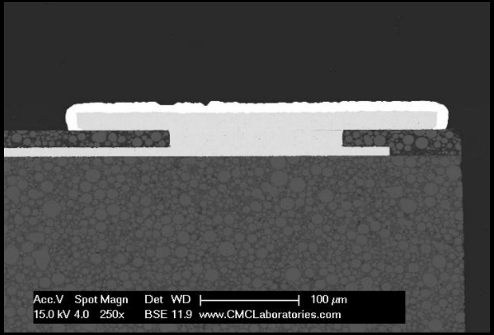


Wettable Flanks - MDQFN

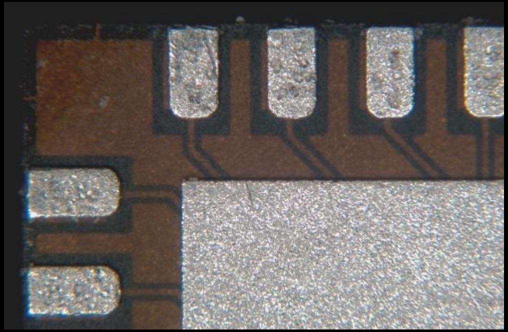
360° wettable flank on every pad



Wettable Flanks



Detail of MDQFN Lead



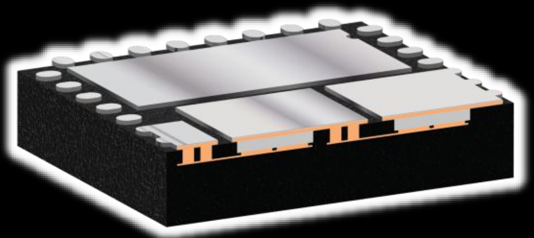
Top View of MDQFN LGAs

"Wettable Flank" is achieved in MDQFN process flow without added cost

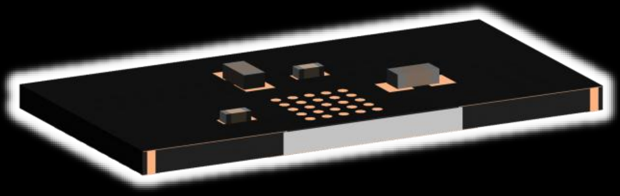
- No partial saw process required
- No exposed Cu – reduced oxidation and corrosion
- Fully wettable flanks around all sides of leads and flag

Additional Features

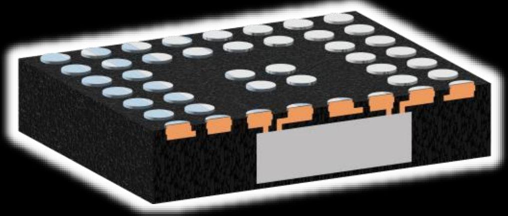
- Dual sided routing
- Thick Cu for high power
- Backside passives
- Flexible footprint



Power Application



Backside Passives and BGA



Area Array

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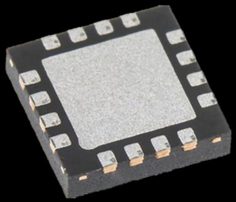
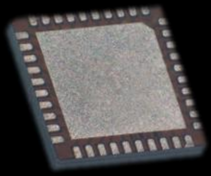
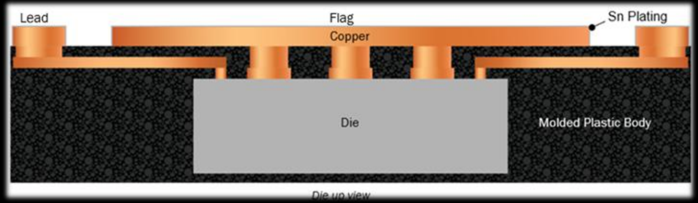
Leadframe QFN vs MDQFN



Leadframe QFN

Wirebond or flip chip built on a leadframe

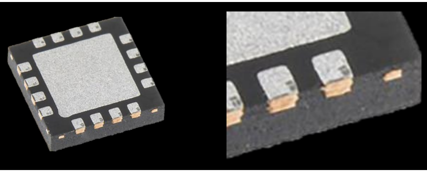
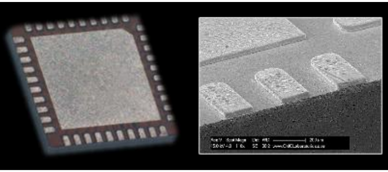




MDQFN (M-Series Direct QFN)

Chips first fan out built on a panel

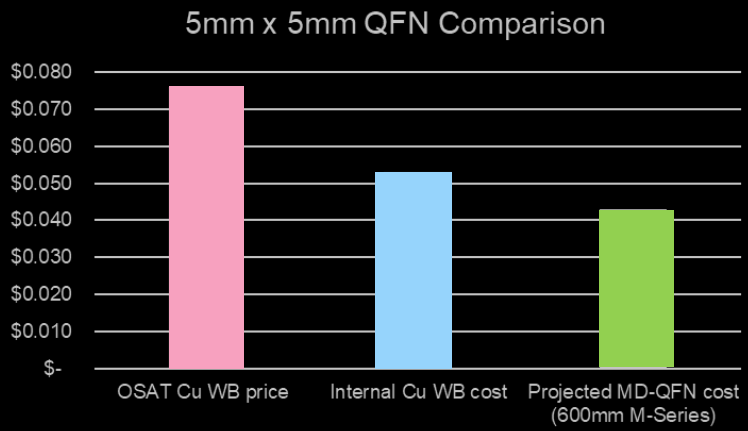
Leadframe QFN vs MDQFN

Items	Leadframe Based QFN	M-Series Direct QFN
Structure **(one metal layer)**		
Features	Interconnect: Flip chip or wirebonds Leadframe or substrate Mold (transfer or compression)	Interconnect: RDL buildup Chips first face up die Double compression mold
Package Design Flexibility	Limited to leadframe (single or dual row QFN)	No Limitations (full area array possible)
Wettable Flank	Outer edge of the package, requires dual saw process (added cost)	All sides of the LGA and flag, inherent to process (no cost added)
Parts Inventory	Required (Leadframe)	Not required (Leadframe free, fully additive solution)
Exposed Copper	Yes, on the sidewalls can result in Cu burrs	No exposed Cu
Strip Test	Standard strip size	Compatible with any strip format and extendable to 600mm panel test
Package thickness	Min: 0.35mm ± 0.05 Standard: 0.8mm to 1mm	Range: 0.1mm to 1.5mm
Cost	Low initial cost	Reduced per-unit cost at scale

MDQFN Cost Comparison

Estimated 20% to 40% reduction as compared to conventional leadframe assembly

- ~20% on 5mm x 5mm body size on 600mm panel
- ~40% on 2mm x 2mm body size on 600mm panel



As modeled by leading IDM

Note: Multiple patents issued & pending

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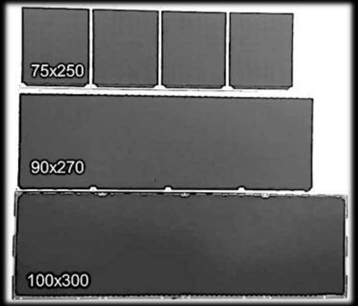
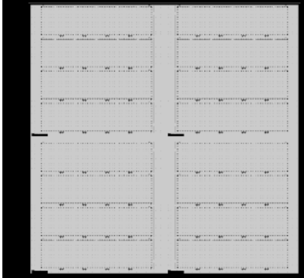
Manufacturing Format

Significant expansion in manufacturing efficiency



Strip-based

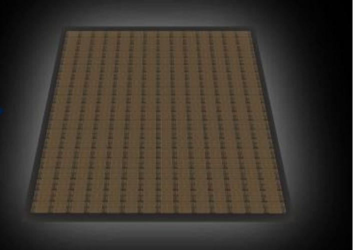


Strip on panel

(strip test)

Segmented panel

(300mm test)



Full panel

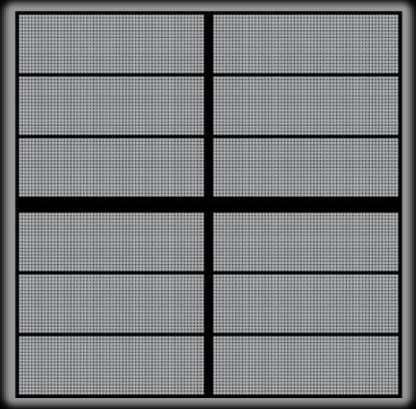
(600mm test)

Large panel-based

Manufacturing Formats

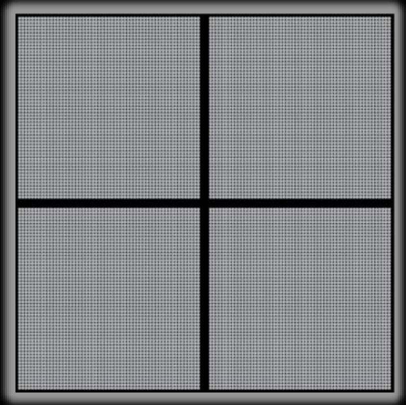
600mm panel example for 5mm x 5mm

Creating assembly strips
100mm x 300mm



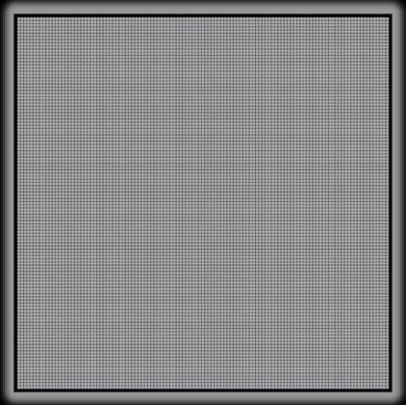
86% area efficiency*
12,312 packages
(1026 units per strip)

Segmented panel
300mm x 300mm quadrants



90% area efficiency*
12,996 packages
(3249 per quadrant)

Full panel
600mm x 600mm



95% area efficiency*
13,689 packages

*Ratio of total package area ÷ total panel area

Manufacturing Formats

Number of QFN units per panel

Body Size (mm)	1 x 1	2x2	3x3	4x4	5x5	6x6	7x7	8x8	9x9	10x10
a) Units per 600mm panel with 100x300mm strips	288,144	74,448	34,200	18,744	12,312	8,460	6,396	4,752	3,840	3,024
b) Units per 600mm segmented panel	304,704	79,524	36,100	20,164	12,996	8,836	6,724	5,184	4,096	3,136
c) Units per full 600mm	314,721	82,369	37,249	21,025	13,456	9,409	6,889	5,329	4,225	3,364

vs. 947 units in a single strip of 70mm x 250mm

Assumptions:
1. 50 micron saw street
2. 5mm edge exclusion

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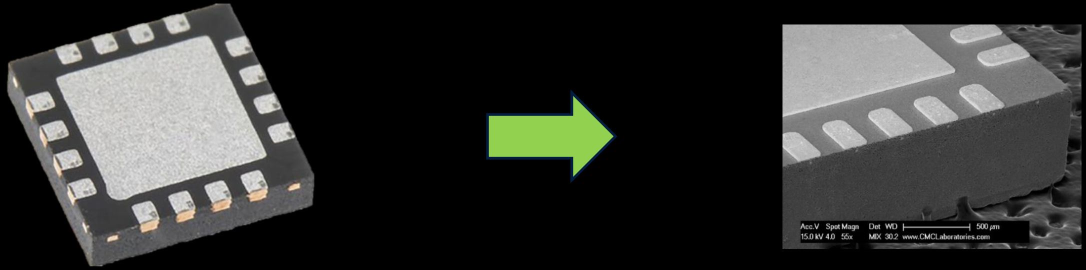
Conclusions

- Leadframe QFN is the “work horse” of the industry and continuing to grow
- Custom leadframes, limited footprints, & exposed Cu are notable limitations
- MDQFN provides:
  - leadframe free QFN package
  - 100% wettable flank
  - enhanced manufacturing efficiency on a 600 mm panel format



MDQFN offers a highly scalable cost-effective solution

Thank you from DECA

Special Acknowledgement to:

Jan Kellar

Tim Olson