

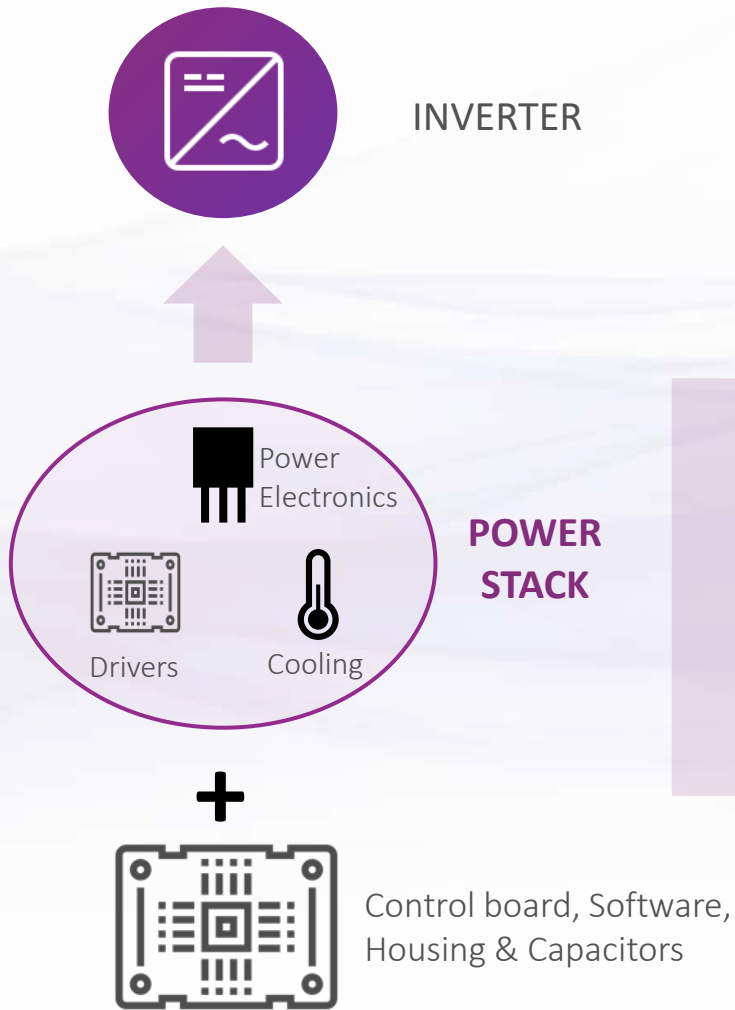
The logo for MAREL POWER SOLUTIONS. The word "MAREL" is in a large, bold, black sans-serif font. To the left of the "M" are three vertical purple bars of varying heights. Below "MAREL", the words "POWER SOLUTIONS" are written in a smaller, purple, all-caps sans-serif font. A thin vertical black line is positioned to the right of the logo.

MAREL

POWER SOLUTIONS

June 2023

MAREL MAKES POWER STACKS



MAREL's Power Stacks use a '**MODULAR**' approach, enabling immediate, custom, and tuned solutions

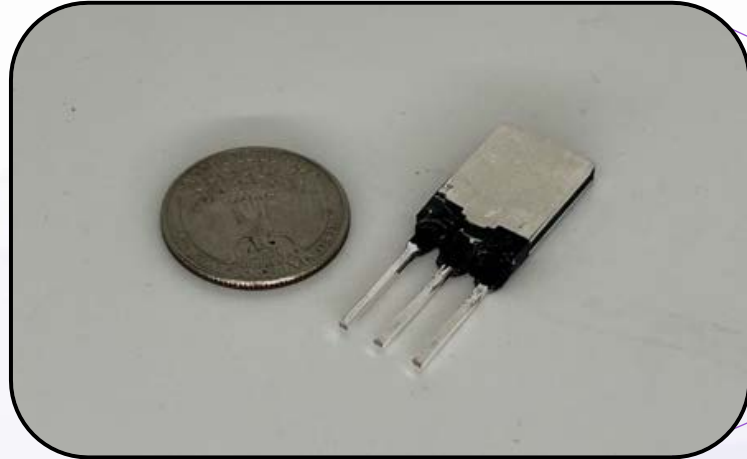
Miniaturized
> 75% smaller
> 50% lighter

Scalable
10kW to 1000kW+
400V to 800V

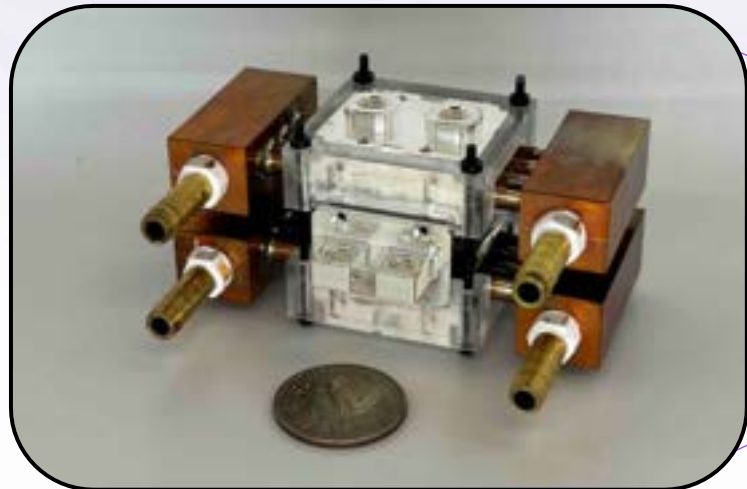
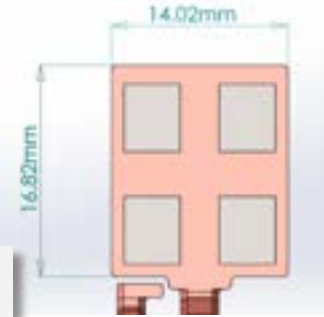
Security of Supply
Use any die
Use any technology

Fewer Power Semis
25% to 50% fewer
Or more power w/ same die

Marel *Innovative Cooling*



Extremely Dense
Power Package



Extremely
Unrestricted
Thermal Path

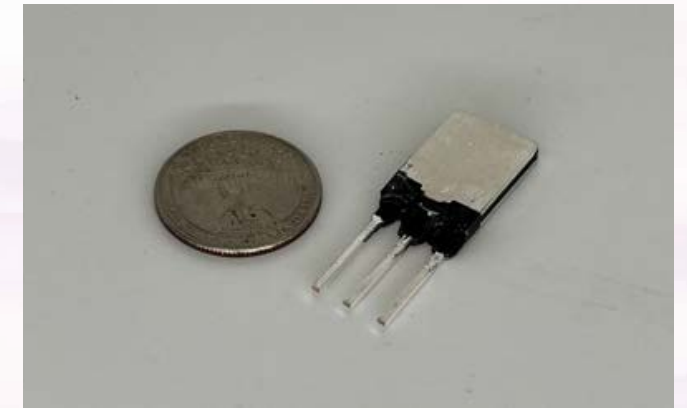
- Direct Connection
Die to Heat Sink
- Relocated & Reduced
Dielectric Barrier

5X Current
in the same package

MAREL builds EXTREMELY POWER-DENSE PACKAGES for POWER-DIE

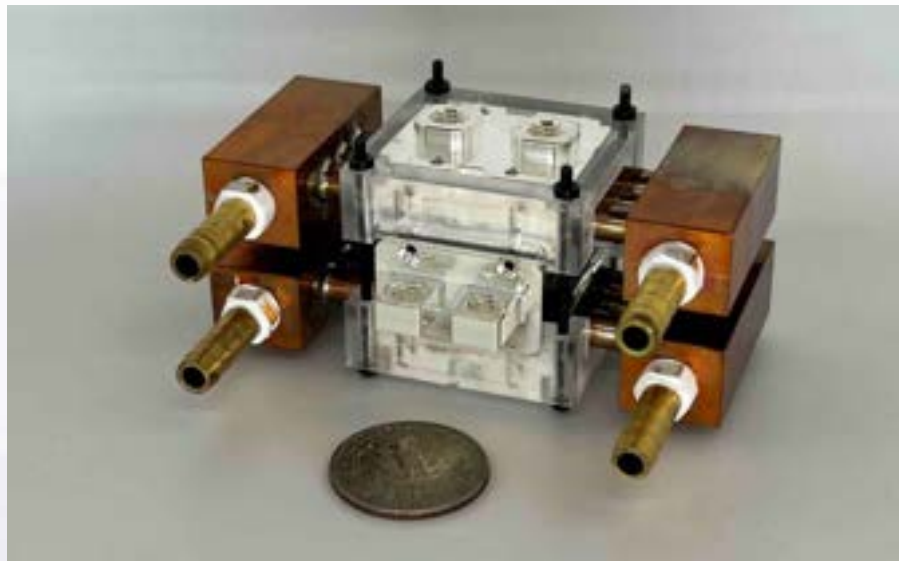
	Standard package		MAREL package
# of Power Semiconductors	1		4
Cooling	single-side		double-side
Thermal Resistance (T_j-T_c)	0.27 C/W	-95%	<0.02 C/W
Power Dissipation @ 175C T_j	208W	5X	1280W
Continuous Current @ 100C T_c	85A		420A
Path Inductance	>15nH	-95%	<<1nH

Comparisons are for a standard TO-247 package



**MEANINGFUL ONLY IF
THE PACKAGE CAN BE COOLED ...**

MAREL POWER STACK extracts HEAT in MULTIPLE DIMENSIONS



MAREL HALF-BRIDGE POWER STACK

- 2 cooled MAREL Packages (8 die) per Switch
- 4 cooled MAREL Packages per Half-Bridge
- 16 cooled die per Half-Bridge

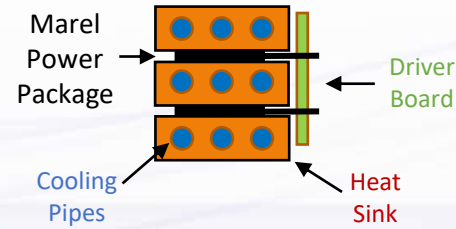
	TODAY'S LEAD TECHNOLOGY		MAREL POWER STACK UNIT
Thermal Resistance (K/W) (Junction to Fluid)	0.1	-50% →	0.048
Max Heat Dissipation (W) per Switch	1250	+105% →	2560
Max Heat Dissipation (W) per Die	156		320
Amps per Switch (A)	560	+50% →	840
Amps per Die (A)	70		105

Half-Bridge Comparison, 8 Die/Switch, 16
Total Die, 175C die temp, 65C fluid

vs STATE-OF-THE-ART:
DOUBLE THE HEAT EXTRACTION
50% MORE CURRENT

Half-Bridge Building Block Examples

SINGLE
1 Power
Module / Switch



MAREL Power
Module /
Die Per Switch

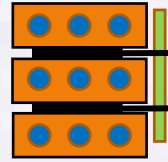
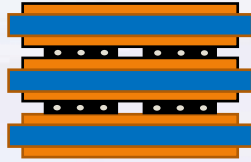
1 / 4

Continuous
Current /
Switch

210A (2 Die / Package)

420A (4 Die / Package)

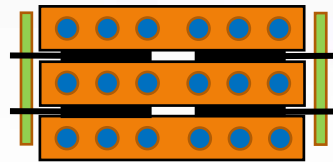
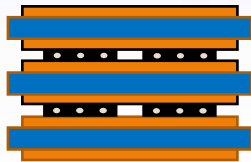
DOUBLE
2 Power Modules /
Switch



2 / 8

840A

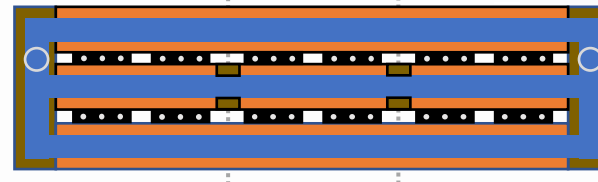
QUAD
4 Power Modules /
Switch



4 / 16

1680A

Multiple Half-Bridges
can be ganged together

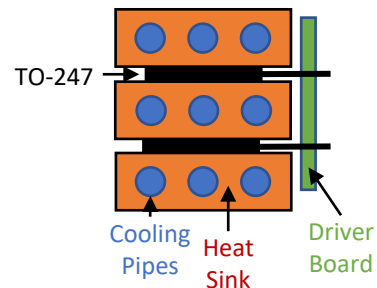
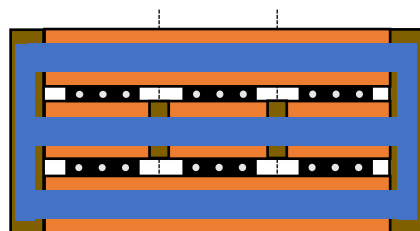


Example: 3HB Double

THE MAREL POWER STACK

3-Phase Inverter Options

SINGLE



MAREL Power Module / Die Per Switch

1 / 4

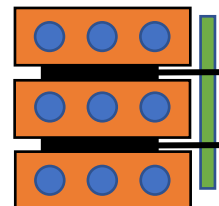
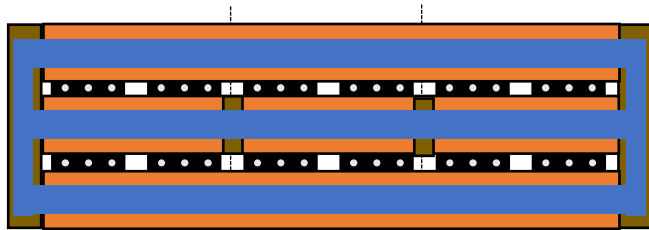
Motor Power (@800V)

375kW

Inverter Estimate Kg / L*

2kg / 1L

DOUBLE

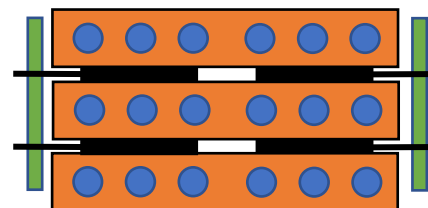
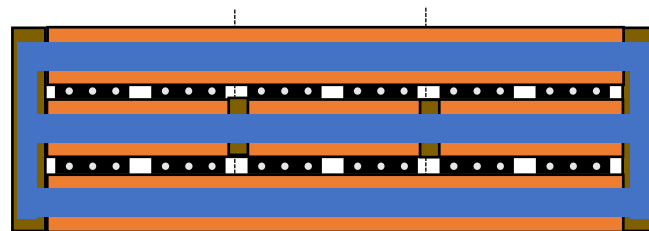


2 / 8

750kW

3kg / 2L

QUAD



4 / 16

1500kW

6kg / 4L

* Estimate includes power stack, control board, DC-link capacitance, housing and connectors

MAREL
POWER STACKS can
be **COMBINED** into
EXTREMELY DENSE
CONVERTERS

750 kW Motor
840 Amps @ 800V



3-Phase Inverter

3 Marel Half Bridge Power Stacks
shown with representative control board, bulk capacitor

Signed contract to manufacture at LINAMAR's Innovation Hub in Guelph Ontario



Linamar iHub:

- Class 7 Clean Room / Over 700 square feet
- Construction Completed
- Installation of equipment in process

Prototype Samples expected Q4 2023

Linamar is Canada's second-largest automotive parts manufacturer

INTERDISCIPLINARY & EXPERIENCED LEADERSHIP TEAM



AMRIT VIVEKANAND
CEO

General Mgmt. & Broad Automotive
U of Madras, Duke U & Harvard BS



MIKE MARCZI
PRESIDENT & FOUNDER

Material Science
Rutgers U



IAN BYERS
CTO

Semiconductor to Systems Design
Purdue U & Wayne State U



GARY MILLER
COO

Product Development
U of Michigan



ANTONELLA GRIMALDI
MANUFACTURING

Process & Quality
Wayne State U & U of Michigan



DR STUART WOOTERS
PRODUCT ENGINEERING

Semiconductor Design
Brigham Young U & U of Virginia



MARTIN BAKER
SALES

Product Dev & Biz Dev
Imperial College & London BS



MIKE GRIMES
BUSINESS STRATEGY & PROD PLANNING

Automotive Systems Development
GMI/Kettering U & Stanford U



JEAN PIERRE FOURNIER
INDUSTRIAL & RENEWABLES SALES

Startup & Manufacturing
Université Laval, Quebec



SRINI MALIPETTI
PRODUCT DEVELOPMENT & SUPPLY CHAIN

Purchasing & Supply Chain
U of New Orleans



4 w/ startup experience, w/ 2 having led startups
5 w/ automotive production experience
Expertise in mechanical, electrical, & materials





POWER SOLUTIONS