



# Vicor 新一代电源方案在智能制造领域的应用

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May 2020



# Catalog

- About Vicor Corporation
- Robotics market
- New generation isolated power module DCM – turnkey solution.



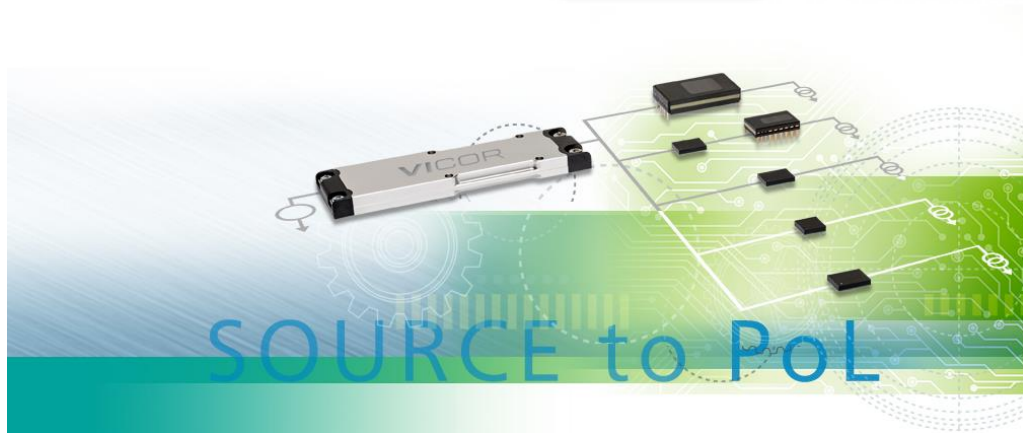


# About Vicor Corporation



# What is important to you?

- Differentiating your product and improving your customers' satisfaction
- Bringing your product to market faster
- Adapting rapidly to changing design goals
- Using fewer development resources



## ■ Vicor can help you meet your goals!

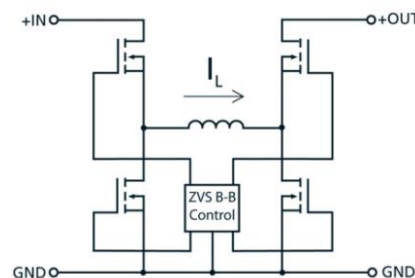
- ✓ Technology leadership
- ✓ Small size, low profile
- ✓ Efficiency
- ✓ Scalability
- ✓ Breadth of product
- ✓ Right-first-time development
- ✓ Online tools
- ✓ Technical support

# Topology and control

## ZVS Regulator

Non-isolated, DC-DC regulator

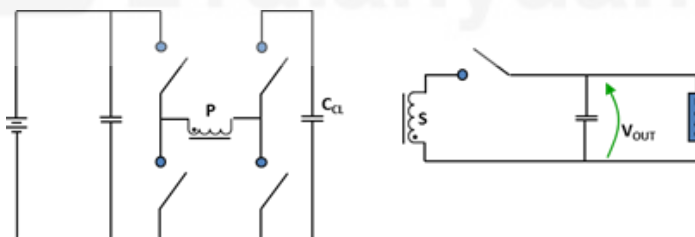
- Pre-Regulator Module (PRM)
- Cool-Power ZVS
  - Buck
  - Boost
  - Buck-Boost



## Double-Clamped ZVS (DC-ZVS)

Isolated, regulated, DC-DC or AC-DC converter

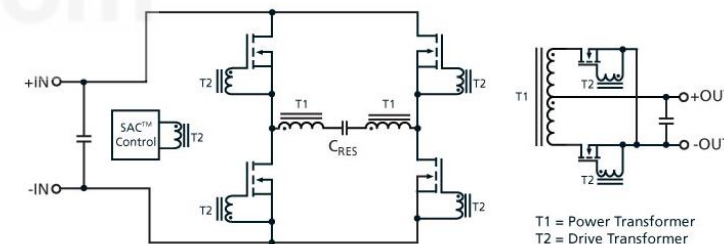
- DC Converter Module (DCM)
- Cool-Power Converters
- Power Factor Module (PFM)



## Sine Amplitude Converter (SAC)

Isolated, fixed-ratio, DC-DC transformer

- Bus Converter Module (BCM)
- Intermediate Bus Converter (IBC)
- Voltage Transformation Module



■ Increasing power density 25% every 2 years

■ Reducing power losses 25% every 2 years

# Packaging technology

VIA

Vicor Integrated Adapter



ChiP

Converter Housed in Package



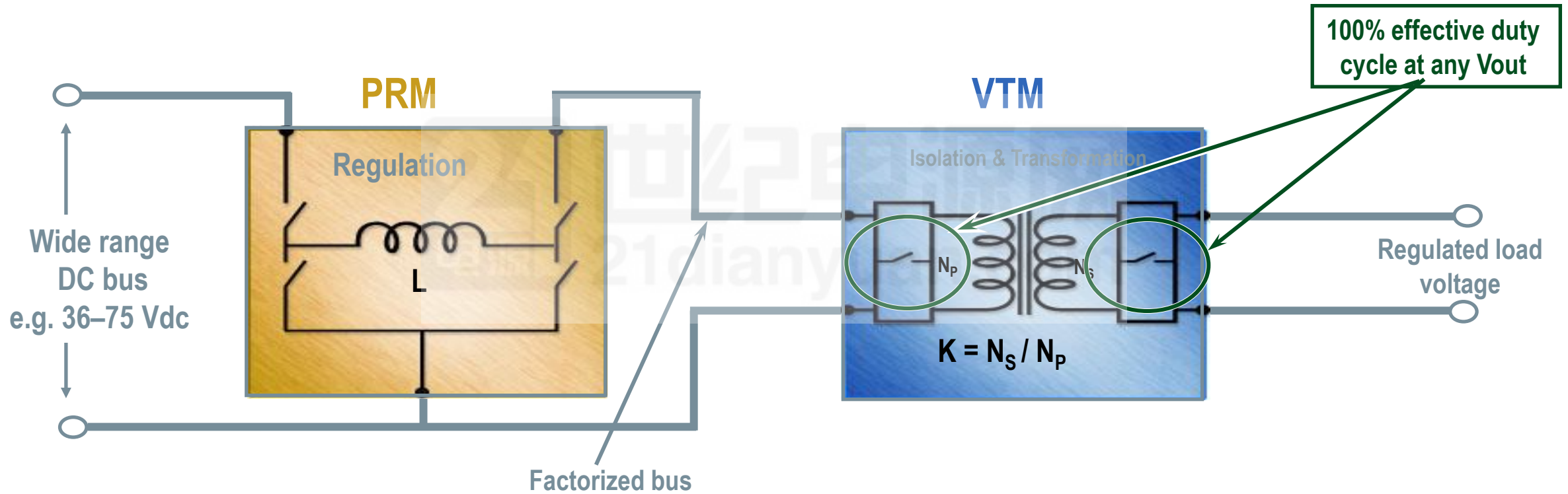
SiP

System in Package



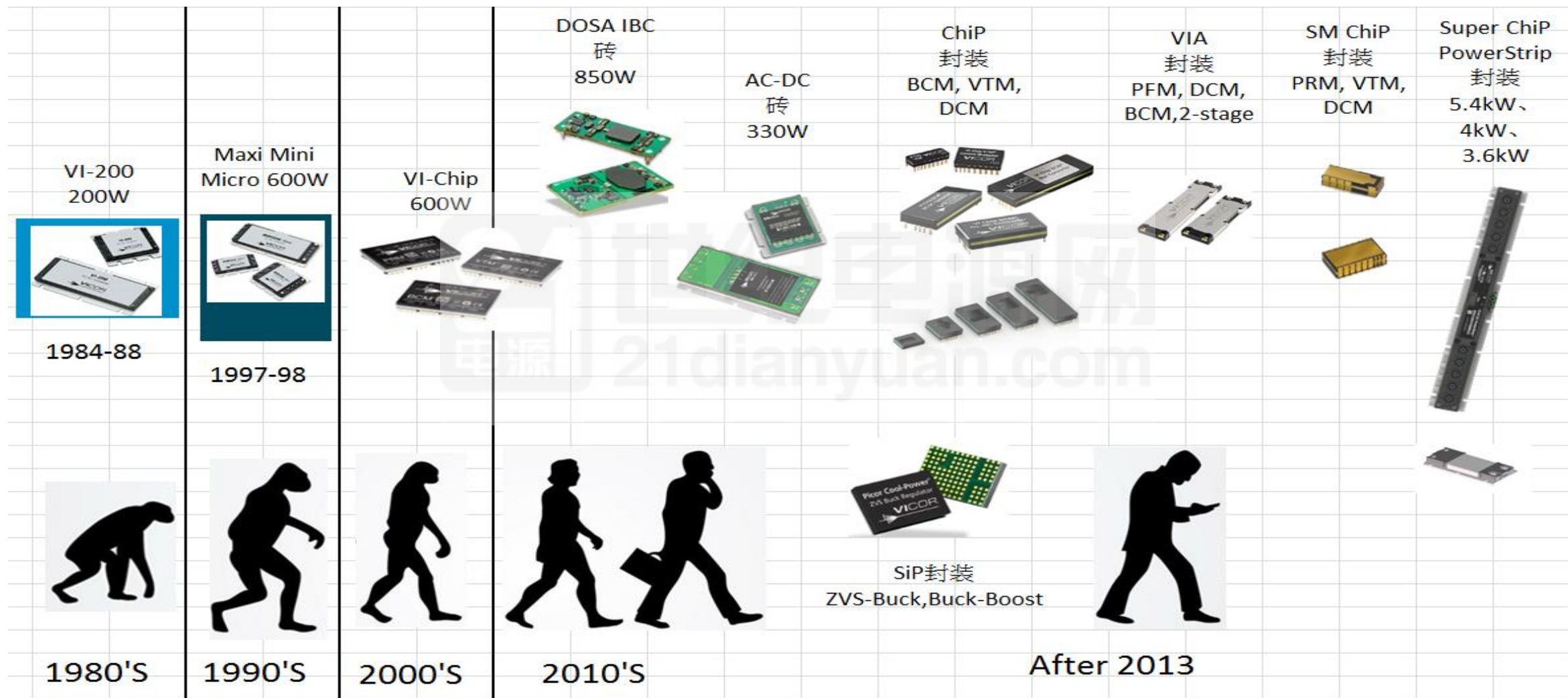
SOURCE to PoL

# Factorized Power Architecture 分比架构





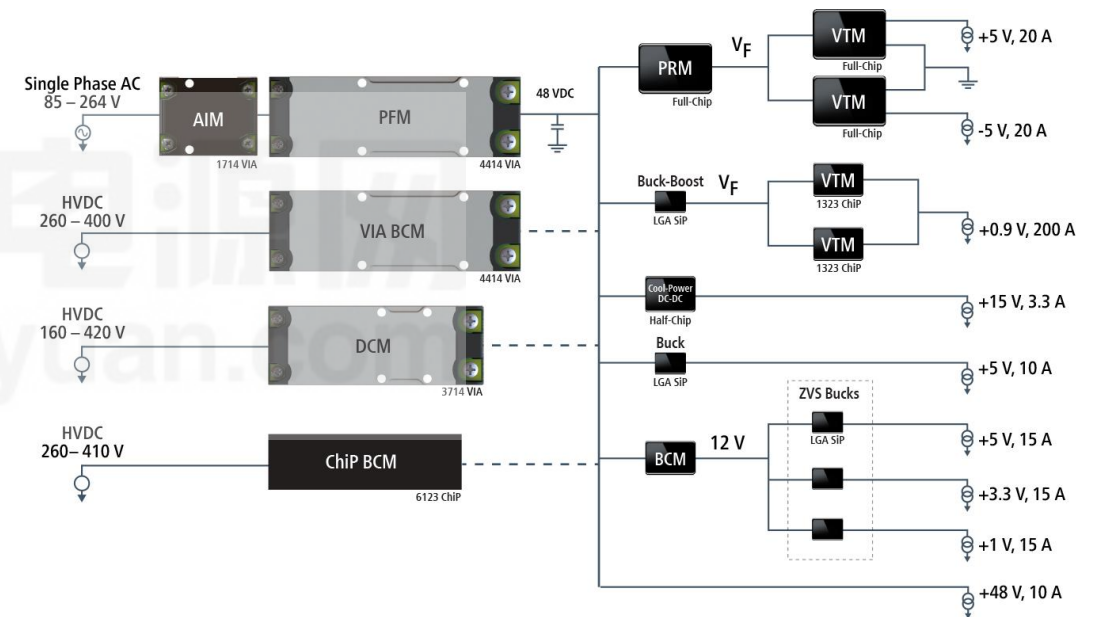
# Vicor 近四十年的产品演进





# Vicor power component design methodology: An optimized approach to power design

- Optimized, modular system building blocks
- Isolated, non-isolated
- AC-input, DC-input
- Regulated, non-regulated
- High voltage, low voltage
- An IC approach to higher power system integration
- Integrated power modules from 25W to over 1,000W
- Input operating voltages from 8V to over 420V (per module)



Example power chain option using power component design methodology

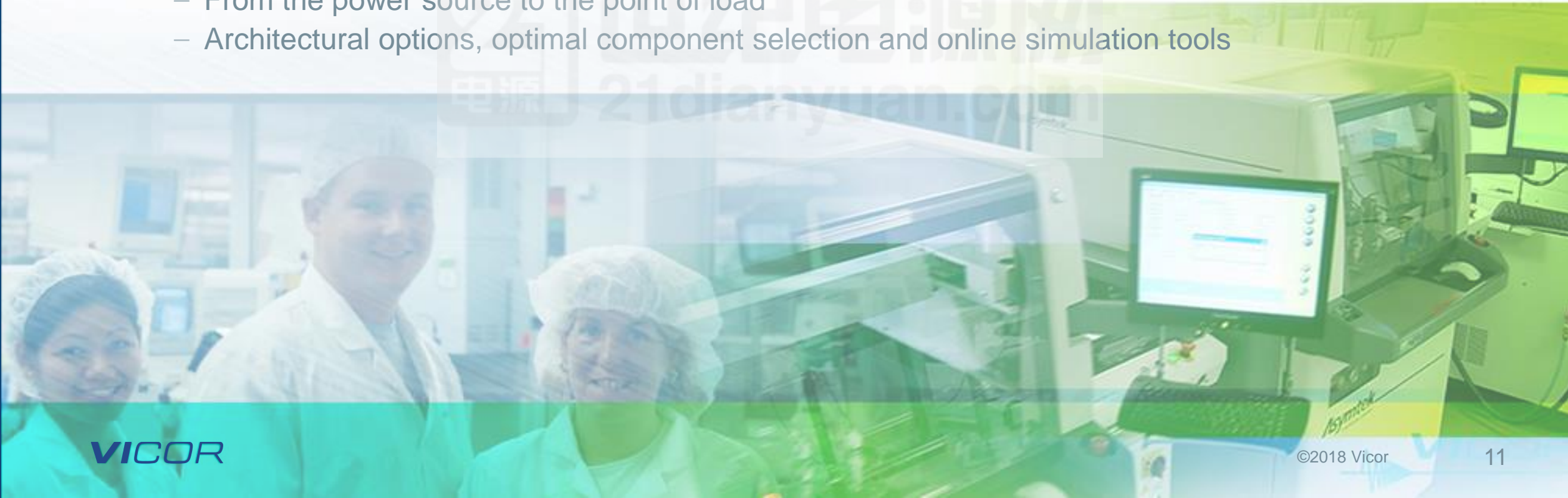
# Markets and applications



- Aircraft test equipment
- Reconnaissance / Targeting Systems
- Radio / Telemetry Systems
- Secure Communications Systems
- Ground Vehicles
- Wireless & Satellite Base Stations
- Broadcast Equipment
- Power Amplifiers
- Microwave Communication
- Remote Telemetry Communication
- Enterprise Servers
- Optical Switchers
- Data Storage Systems
- Network Servers
- Super Computers
- ATE
- Process Control
- Energy
- Lighting
- **Factory Automation**
- **Transportation/ Railroad**
- Electric / Hybrid Vehicles
- Commercial / Aftermarket

# About Vicor

- Founded in 1981 on a platform of innovation
  - 170+ patents on power trains, control systems, components and packaging technology
  - 16% of gross revenue re-invested in R&D
- High density, high efficiency modular solutions to power system requirements
  - From the power source to the point of load
  - Architectural options, optimal component selection and online simulation tools



# Robotics Market

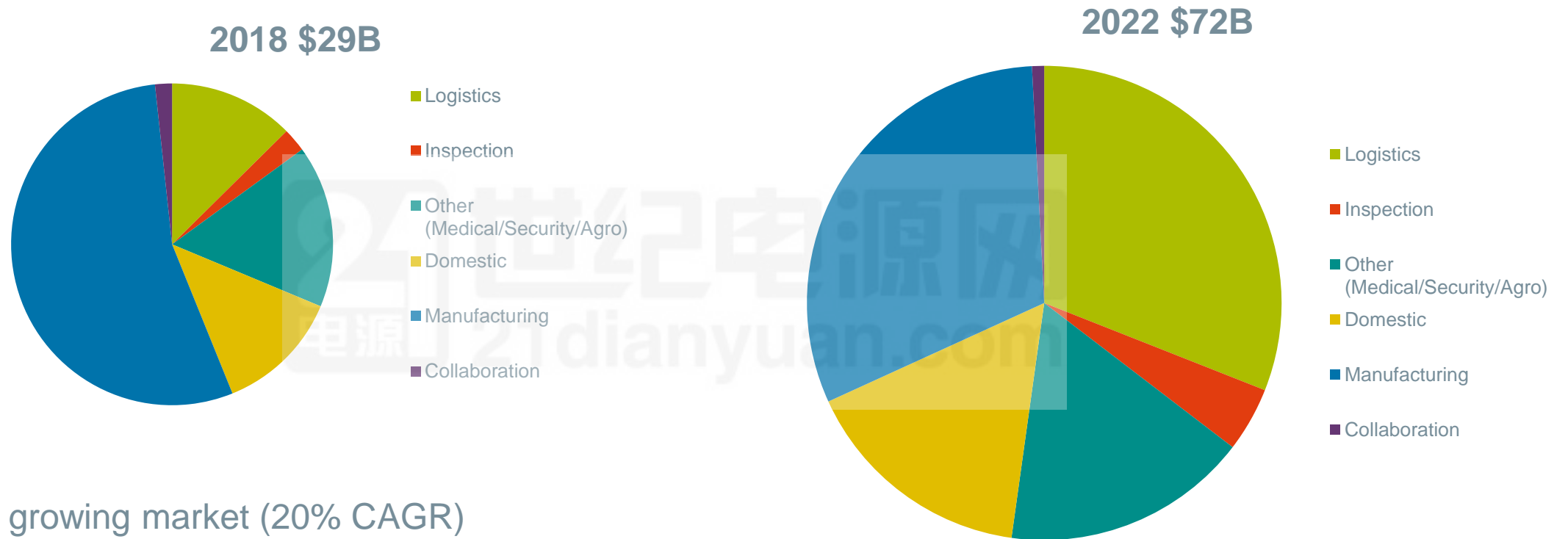


# LAWS OF ROBOTICS

- A robot may not injure a human being or, by failing to act, allow a human being to come to harm.
- A robot must obey orders given to it by human beings, except where carrying out those orders would break the First Law.
- A robot must protect its own existence, as long as the things it does to protect itself do not break the First or Second Law

Isaac Asimov, 1942

# Robotics WW sales projections



Fast growing market (20% CAGR)

Significant size

Logistics – autonomous ground vehicles (AGV) growing fastest

Non-domestic use robotics markets value Vicor attributes

Source: [www.ifr.org](http://www.ifr.org) 2019



# Challenges for Robotics Manufacturers

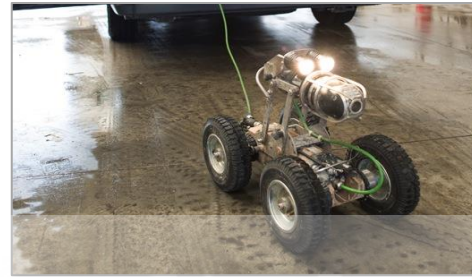
## Service Robots:

### Logistics



More autonomy  
Improved safety  
Extend range

### Inspection



Reliability in harsh environments  
Smaller, for confined spaces  
Longer battery life or tether

### Security



Extend operation time  
Safety around humans  
Increased functionality (AI)

## Industrial Robots

### Manufacturing



Faster Processing (AI)  
Reduce downtime  
SMART, green factories

### Cobots



High reliability and safety  
Improved aesthetics (small size)  
More functionality

# Autonomous Warehouse Robot Market

IoT and Industry 4.0 driving trend to SMART factories

Logistics between production lines and warehouses becoming automated

Flexibility required to allow personalization and lot sizes down to one

Typical Market Challenges:

- End customers require rapid, low cost fulfillment
- Shortage of labor in warehouse and delivery (facilitate older workers?)
- Operation in a complex, changing environment

# Security Robot Market

Increases in the cost of labor and shortages of manpower drive up demand  
Sensor and AI technology now make operation around humans possible

## Typical Challenges:

- Reliable operation in sometimes harsh environments
- Autonomous operation 24 hours a day is required



## Actual Documented Successes:

- Detection of armed robbery, burglaries and hit and run incidents (recorded as evidence by on-board sensors)

# DCM2322 Product Materials



# DCM family overview

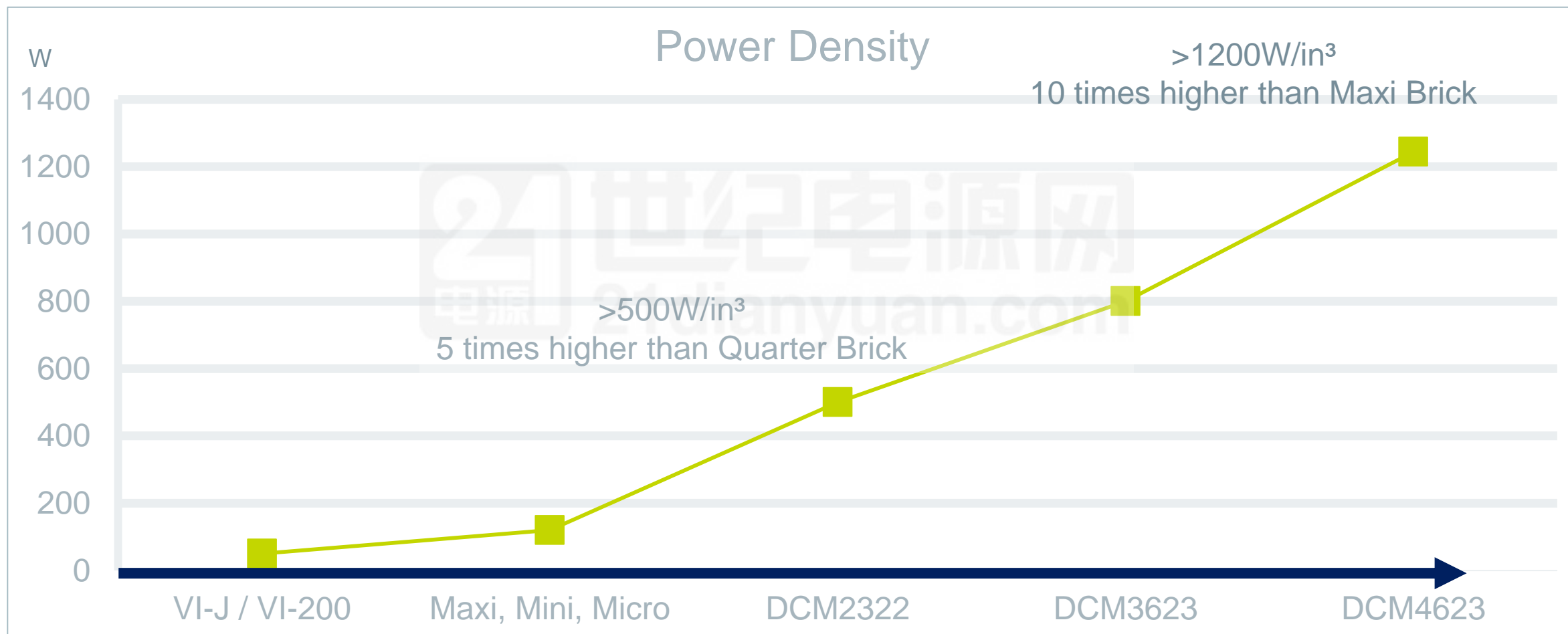
## Family of DCM Products

■ = Also Available in VIA™ package

Nominal Input (V)	Package Size	Power (W) by Nominal Output Voltage (V)								
		3.3	5	12	13.8	15	24	28	36	48
300 (180 – 420)	4623 ChiP or 3714 VIA			400	500		600	500		500
290 (160 – 420)	4623 ChiP				600					
275 (120 – 420)	4623 ChiP	110	190	375		375	375	375		375
270 (160 – 420)	4623 ChiP or 3714 VIA	150	250	500		500	500	500		500
270 (180 – 400)	5614 VIA							1300		
100 (43 – 154)	3623 ChiP	80	120	240		240	240	240		240
100 (43 – 154)	2322 ChiP	40	60	120		120	120	120		120
48 (36 – 75)	3623 ChiP or 3414 VIA		160	320		320	320	320	320	320
43 (14 – 72)	2322 ChiP	35	50	100		100	100	100		100
42 (9 – 75)	3623 ChiP			80		80	80	80		80
30 (9 – 50)	3623 ChiP	80	80	160		160	160	160		160
30 (9 – 50)	2322 ChiP			60		60	60	60		60
28 (16 – 50)	3623 ChiP or 3414 VIA	120	180	320		320	320	320		320
24 (18 – 36)	3623 ChiP		180	320		320	320	320	320	320



# Vicor innovates ahead of the power density curve



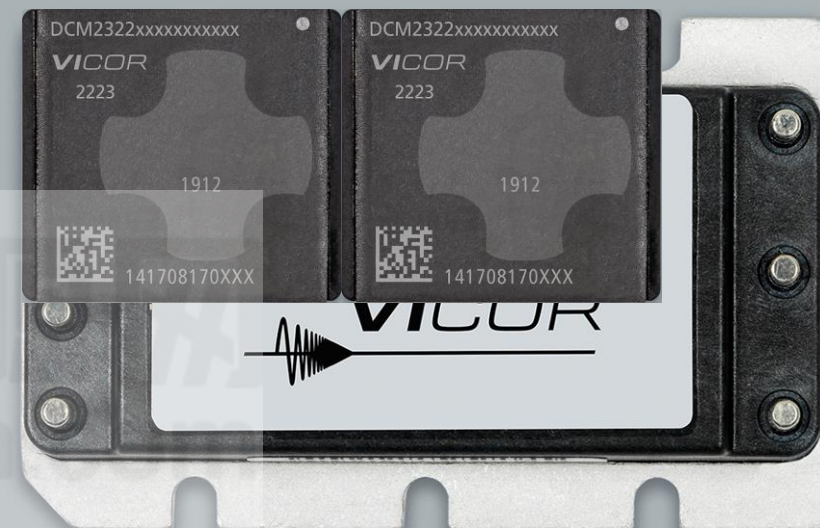


# Power density is the key to success



Half Brick: 300W

DCM3623: 240W



Quarter Brick: 150W




DCM2322: 120W

240W in  $\frac{1}{2}$  area of 150W Quarter Brick

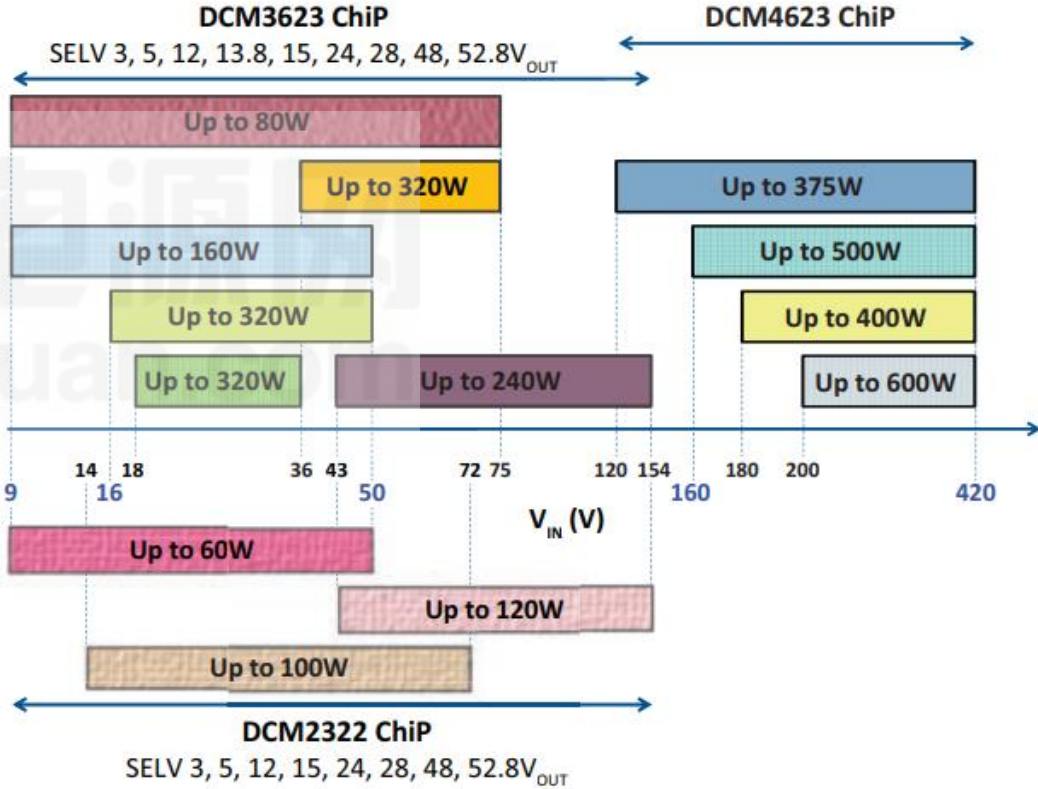
**VICOR**

480W in  $\frac{2}{3}$  area of 300W  $\frac{1}{2}$  Brick

110V 输入的Vicor 三代产品的比较

Parameter	<div> Vi-JT3-CW</div>	<div> V110C24T100BG</div>	<div> DCM3623TA5N26B4T70</div>
Input / Output Voltage	66-160V <sub>IN</sub> / 24 V <sub>OUT</sub>	66-154V <sub>IN</sub> / 24 V <sub>OUT</sub>	43-154V <sub>IN</sub> / 24 V <sub>OUT</sub>
Power	100W	100 W	120 W
Efficiency	85%	87.4%	90.6%
Dimensions	61 x 57.9 x 12.7mm	57.9 x 36.8 x12.7 mm	24.84 x 22.8 x 7.21 mm
Trim range	50%~110%	10%~110%	60%~110%
Solution Power Density	50 W/in <sup>3</sup>	91 W/in <sup>3</sup>	532 W/in <sup>3</sup>
Operating Temp. Range	-40° C to +100° C	-40°C to +100°C	-40°C to +125°C
MTBF(70° C case temp)	1.60Mhrs	1.19MHrs	1.71Mhrs

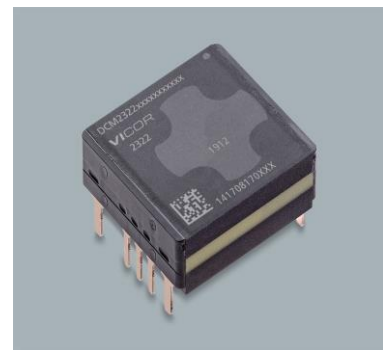
# Vicor-DCM-family



# DCM2322 – Isolated, Regulated, DC-DC Converter

Vin Range (nominal)	3.3Vout	5Vout	12Vout	15Vout	24 Vout	28Vout	48Vout
43-154	40W	60W	120W	120W	120W	120W	120W
14-72	35W	50W	100W	100W	100W	100W	100W
9-50			60W	60W	60W	60W	60W

- >500W/in<sup>3</sup> power density
- Up to 90.5% peak efficiency
- Target markets include rail, military, communications
- OV, OC, UV, short circuit and thermal protection
- Array up to 8 units for 960W (no power derating)



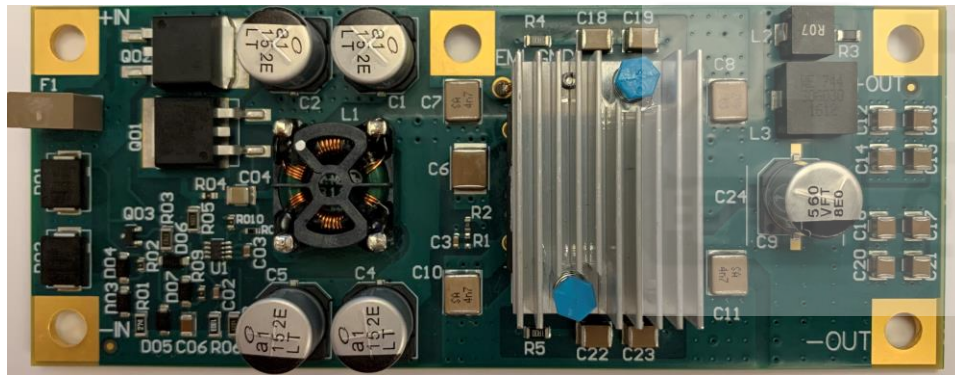
0.97 x 0.90 x 0.28 in



# DCM2322 Reference Design

## ■ Complies with

- EN50121-3-2 Railway Applications – Electromagnetic compatibility Part 3-2: Rolling stock – Apparatus
- Surge tests are complete
  - Passed differential mode surge ( $\pm 1\text{kV}$ ,  $42\Omega$ ) tests
  - Passed common mode surge ( $\pm 2\text{kV}$ ,  $42\Omega$ ) tests



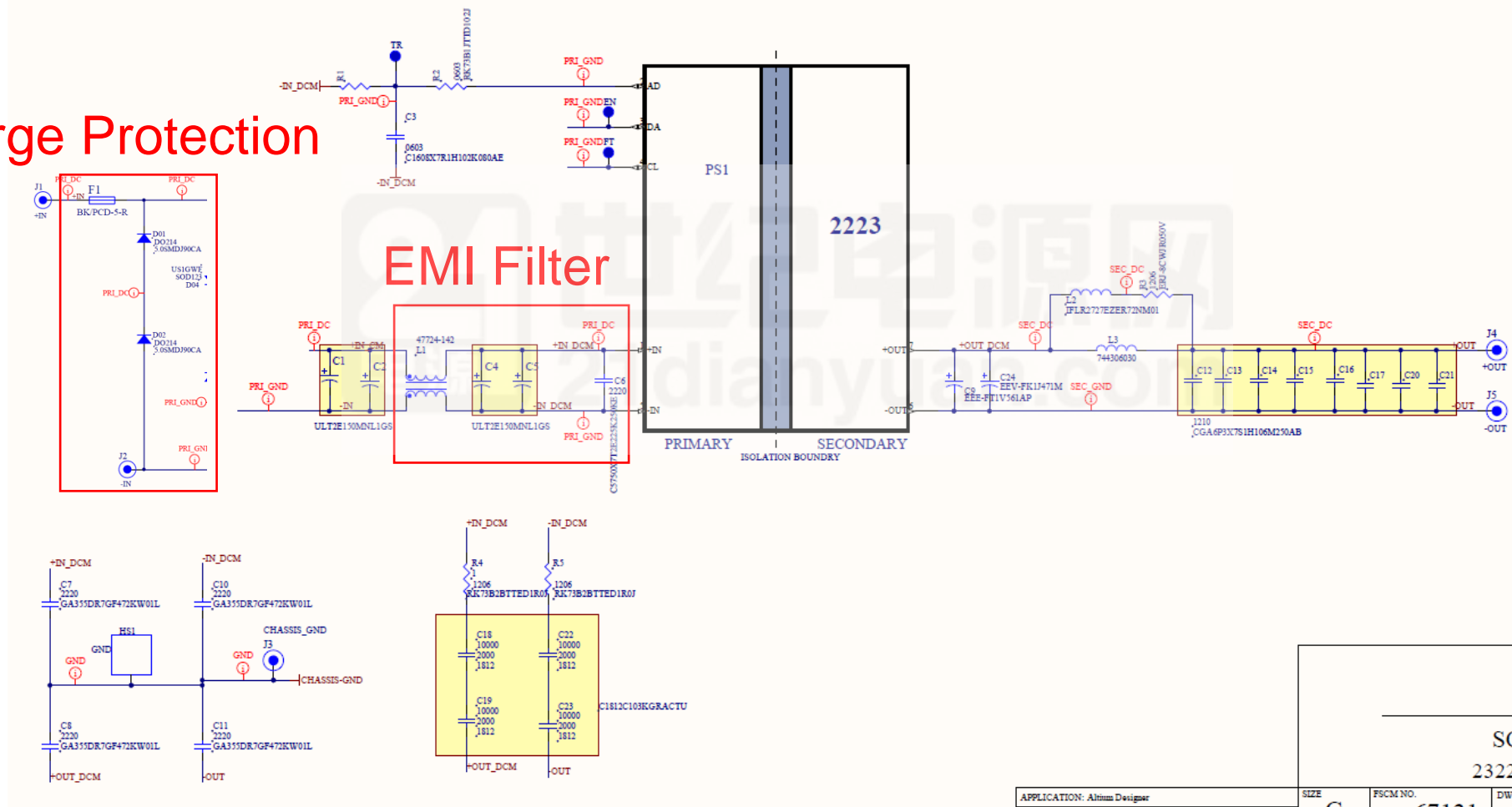
5cm

13cm

# Railroad DCM2322 (43-154Vin range)

Surge Protection

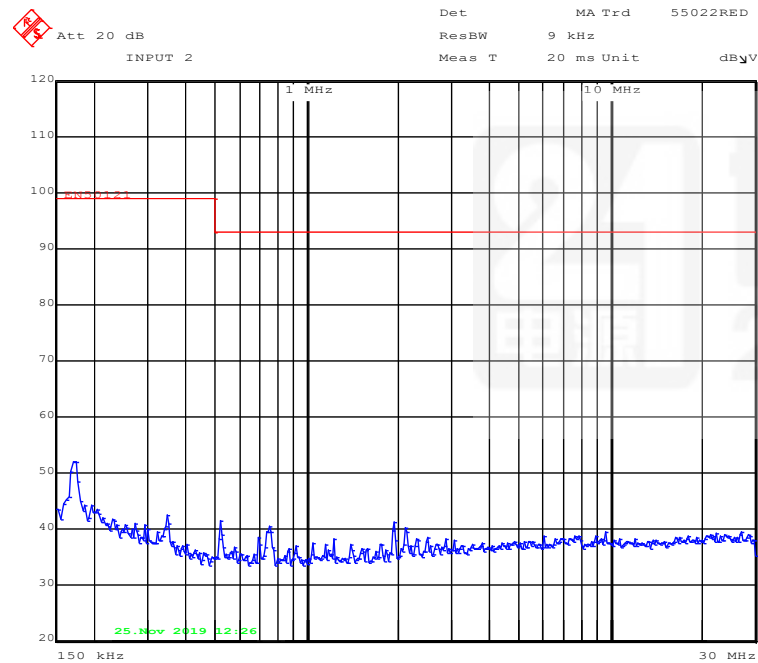
EMI Filter





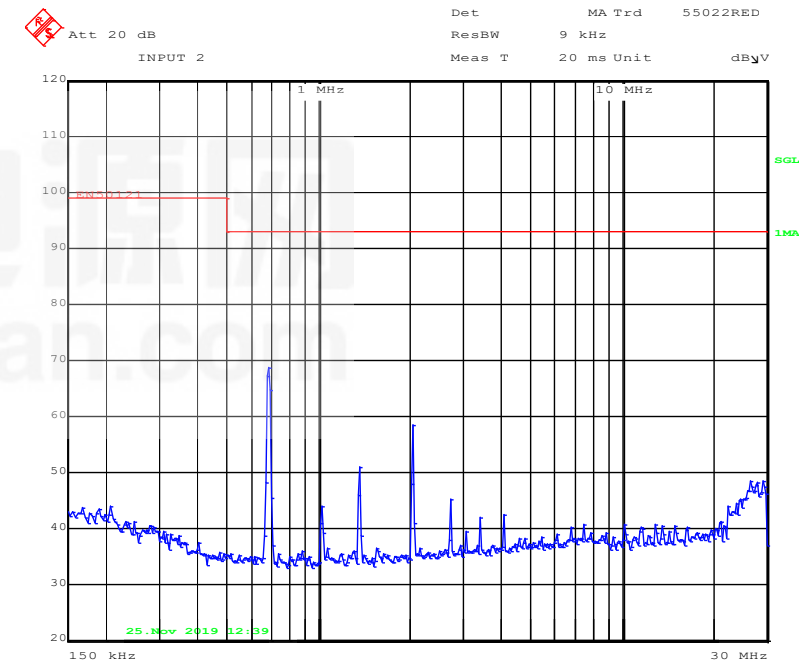
# DCM2322 Conducted Emissions Test Results: $43V_{IN}$

0% Load



Title: Peak  
Comment B: 43Vdc No Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 12:26:53

100% Load

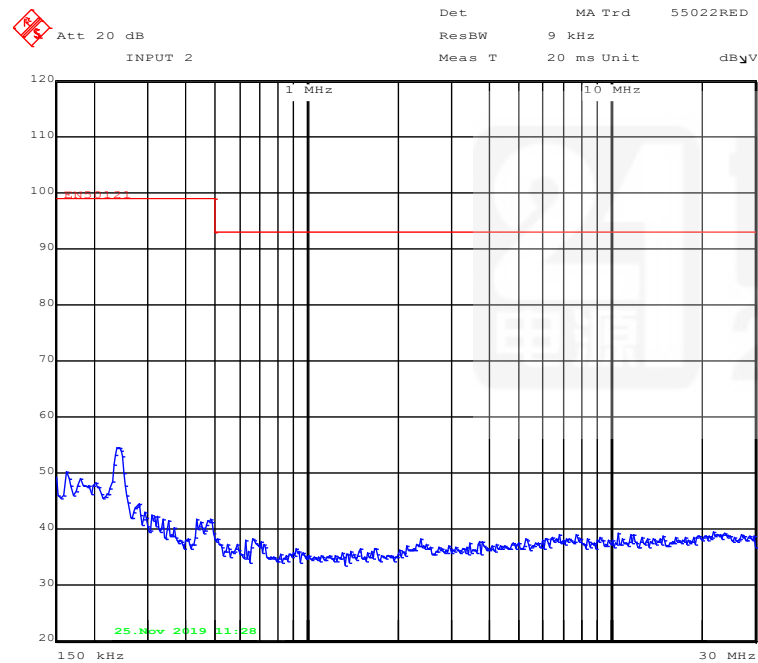


Title: Peak  
Comment B: 43Vdc 100% Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 12:39:12

Figure: EMI scans per EN50121-3-2 for  $43 - 154V_{IN}$  to  $24V_{OUT}$  DC system

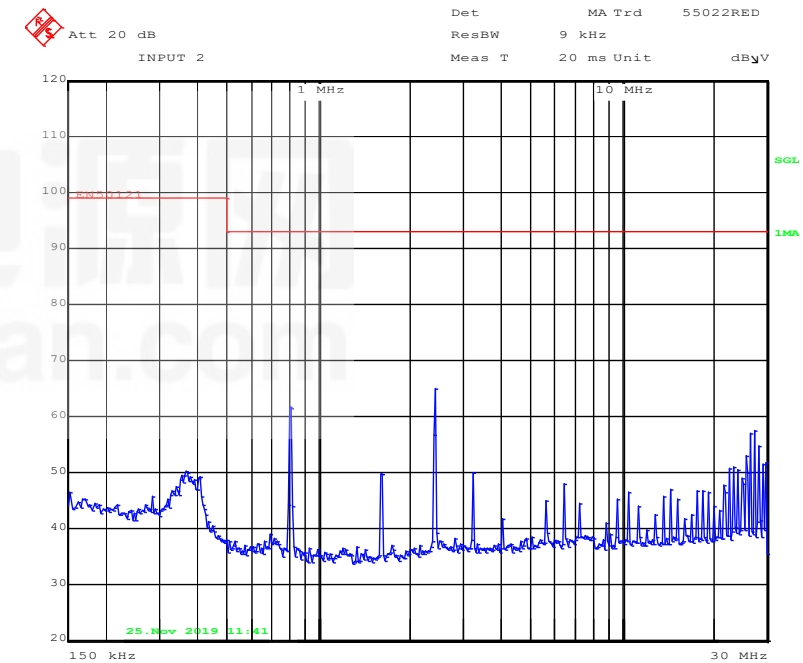
# DCM2322 Conducted Emissions Test Results: $100V_{IN}$

0% Load



Title: Peak  
Comment B: 100Vdc No Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 11:28:38

100% Load

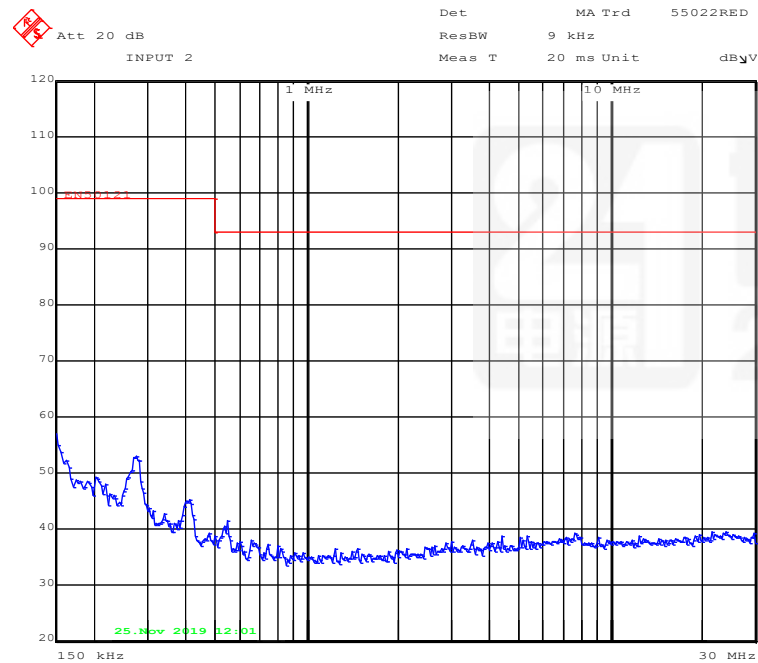


Title: Peak  
Comment B: 100Vdc 100% Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 11:41:07

Figure: EMI scans per EN50121-3-2 for  $43 - 154V_{IN}$  to  $24V_{OUT}$  DC system

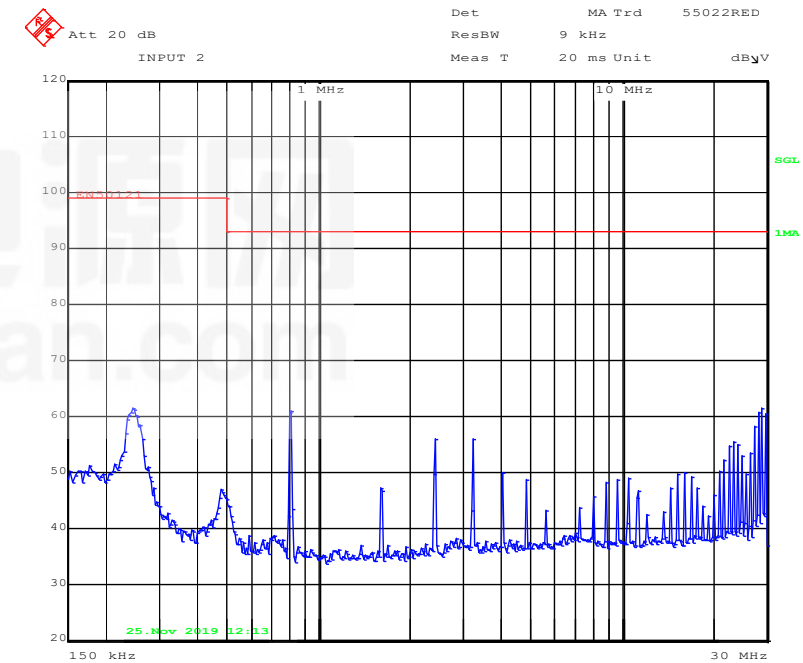
# DCM2322 Conducted Emissions Test Results: $154V_{IN}$

0% Load



Title: Peak  
Comment B: 154Vdc No Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 12:01:42

100% Load



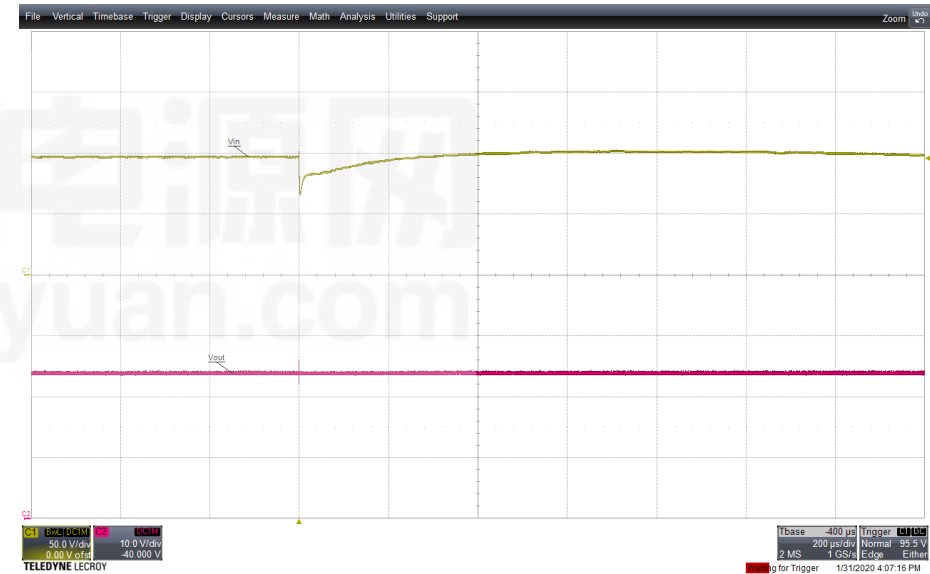
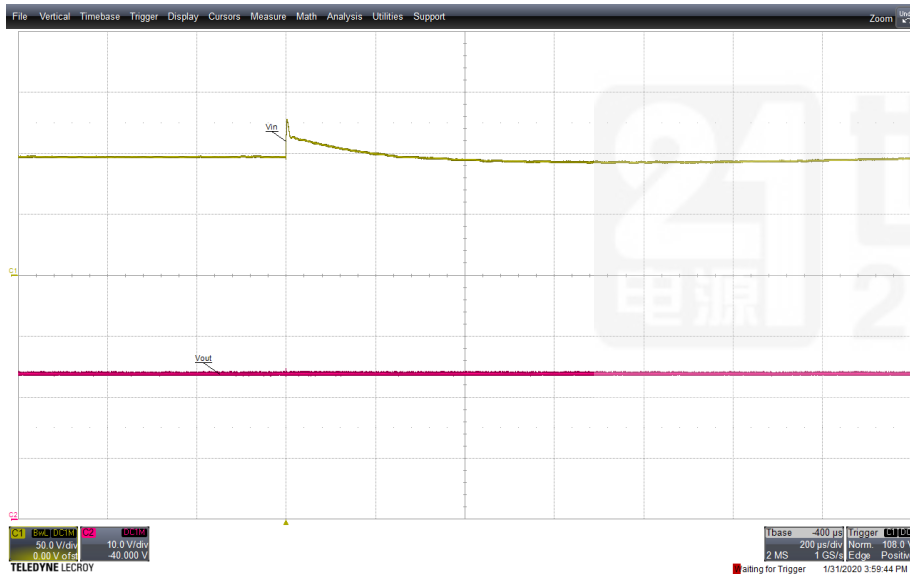
Title: Peak  
Comment B: 154Vdc 100% Load Railway DCM Filter Chip Red Lead  
Date: 25.NOV.2019 12:13:35

Figure: EMI scans per EN50121-3-2 for 43 -  $154V_{IN}$  to  $24V_{OUT}$  DC system

# DCM2322 Surge Test Results: $100V_{IN}$

Differential mode +1kV, 42ohm at 100% Load

Differential mode -1kV, 42ohm at 100% Load

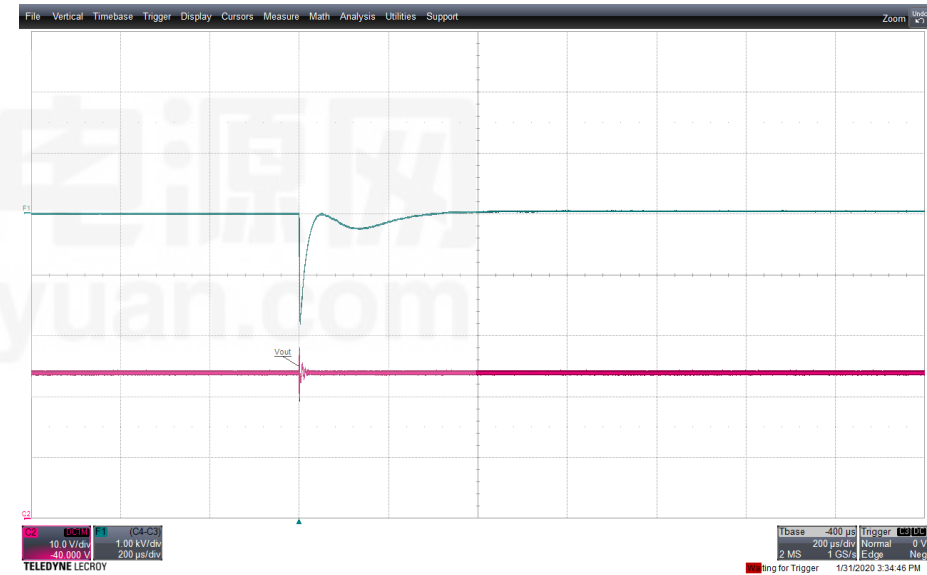


**Figure:** Surge as per EN50121-3-2 for 43 -  $154V_{IN}$  to  $24V_{OUT}$  DC system

# DCM2322 Surge Test Results: $100V_{IN}$

Common mode +2kV, 42ohm at 100% Load

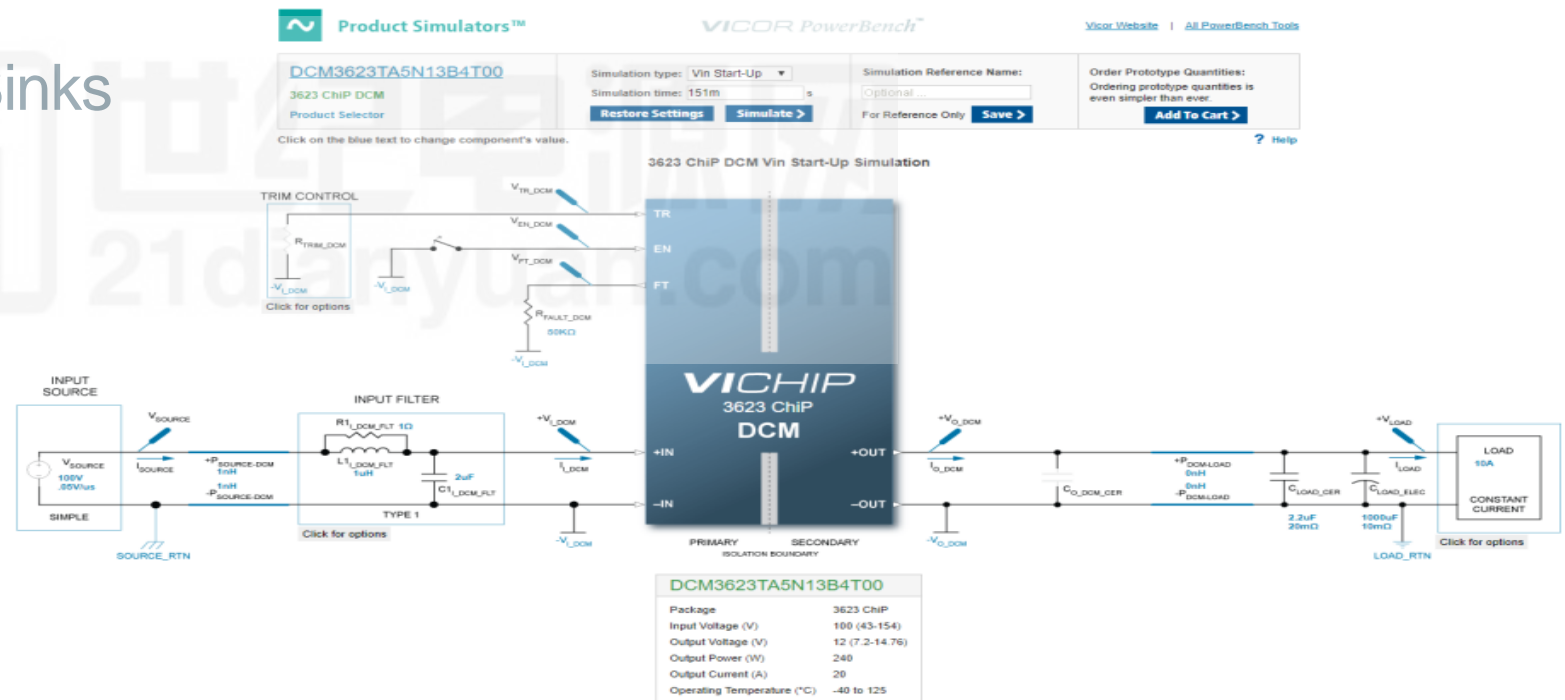
Common mode -2kV, 42ohm at 100% Load



**Figure:** Surge as per EN50121-3-2 for 43 -  $154V_{IN}$  to  $24V_{OUT}$  DC system

# Tools and Design Guides to accelerate time to market

- Simulators : Start-Up, Shutdown, Steady State,  $V_{IN}$  Step, Load Step
- Power System Designer
- Evaluation Boards
- Calculators : Trim, Heat Sinks
- Additional collateral
  - Comprehensive design guide
  - Reference Designs (Schematics, Simulations, Layouts)
    - Array and PoL Operation
- Thermal calculator





# DCM Design Guide

- [http://www.vicorpower.com/documents/design\\_guides/DG-DCM-Design-Guide-VICOR.pdf](http://www.vicorpower.com/documents/design_guides/DG-DCM-Design-Guide-VICOR.pdf)
- Covers various topics, such as
  - Compliance recommended fuse
  - Input, Output filter design
  - Operation of DCMs
    - Parallel operation
  - External loop control for tighter regulation
  - Thermal management
  - Layout guidelines
  - Soldering guidelines

## DCM™ Design Guide

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# EMI Reference Designs box link

- EMI reference designs are available – please see local representative or sales office
- Consists of
  - ☐ Schematic
  - ☐ BOM
  - ☐ Layout files
  - ☐ Test Reports



# Heat Spreaders for ChiP DCMs

- <http://www.vicorpower.com/accessories/thermal-management>

Package Size	Part Number	RoHS Compliant	Recommended Land Pattern	Product Assembly Drawing	Outline Drawing	3-D Model Drawing	
3623 ChiP	47272	Yes	PDF	PDF	PDF DXF	STEP	<a href="#">ADD TO CART</a>
4623 ChiP	47273	Yes	PDF	PDF	PDF DXF	STEP	<a href="#">ADD TO CART</a>
6123 ChiP	47274	Yes	PDF	PDF	PDF DXF	STEP	<a href="#">ADD TO CART</a>

# Thermal Tool

## User Defined Configuration

### Step 1: Model Selection

DCM Thermal Calculator

Vin (V)

Vout (V)

Power (W)

Package

Optimized For

Select filter

Select filter

Select filter

Select filter

Select filter

Reset Filters

Vin (V)	Vout (V)	Power (W)	Package	Optimized For	Part Number
24	5	180	3623 ChiP	Array	DCM3623T36G06A8T00
24	12	320	3623 ChiP	Array	DCM3623T36G13C2Y00
24	15	320	3623 ChiP	Array	DCM3623T36G17C2Y00
24	24	320	3623 ChiP	Array	DCM3623T36G26C2Y00
24	28	320	3623 ChiP	Array	DCM3623T36G31C2Y00
24	36	320	3623 ChiP	Array	DCM3623T36G40C2Y00
24	48	320	3623 ChiP	Array	DCM3623T36G53C2Y00
28	3.3	120	3623 ChiP	Standalone	DCM3623T50M04A2Y7Z
28	5	180	3623 ChiP	Array	DCM3623T50M06A8Y0Z
28	5	180	3623 ChiP	Standalone	DCM3623T50M06A8Y7Z
28	12	320	3623 ChiP	Array	DCM3623T50M13C2Y00
28	12	320	3623 ChiP	Standalone	DCM3623T50M13C2Y7Z
28	15	320	3623 ChiP	Array	DCM3623T50M17C2Y00
28	15	320	3623 ChiP	Standalone	DCM3623T50M17C2Y7Z
28	24	320	3623 ChiP	Array	DCM3623T50M26C2Y00
28	24	320	3623 ChiP	Standalone	DCM3623T50M26C2Y7Z
28	28	320	3623 ChiP	Array	DCM3623T50M31C2Y00
28	28	320	3623 ChiP	Standalone	DCM3623T50M31C2Y7Z
28	48	320	3623 ChiP	Array	DCM3623T50M53C2Y00
28	48	320	3623 ChiP	Standalone	DCM3623T50M53C2Y7Z
30	3.3	80	3623 ChiP	Array	DCM3623T50T048Y0Z
30	3.3	80	3623 ChiP	Standalone	DCM3623T50T048Y7Z
30	5	80	3623 ChiP	Array	DCM3623T50T068Y0Z
30	5	80	3623 ChiP	Standalone	DCM3623T50T068Y7Z

### Step 2: User Inputs

1.524" (38.72 mm)

0.898" (22.8 mm)

0.284" (7.21 mm)

Part Number

Package

Input Voltage

Output Current

Output Power

Product Grade

Cooling Type

Location

Heat Sink Type

Input Voltage

PCB Temperature

Air Velocity

Thermal Interface Material Resistance

DCM3623T36G06A8T00

3623 ChiP

24 (18 to 36) V

36 A

180 W

T

Heat Sink

Top

Top And Bottom

11mm Transverse (40139)

11mm Longitudinal (40143)

24 V

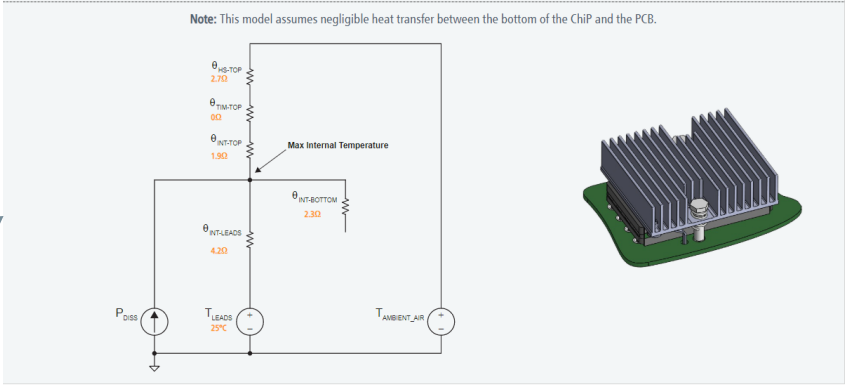
25 °C

800 LFM

0 °C/W

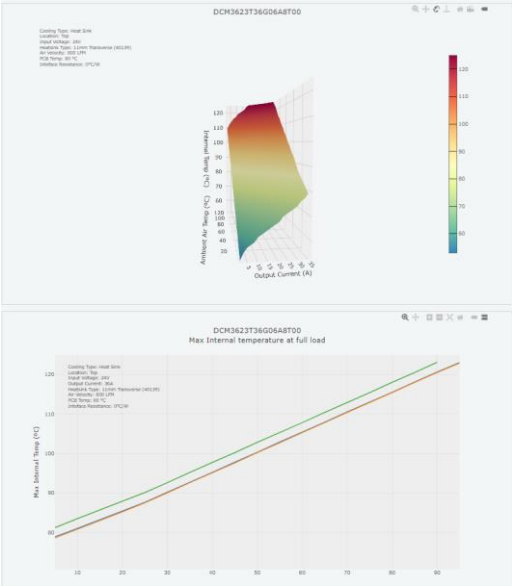
Data Sheet

Calculate



### Results: DCM Internal Temperature Calculations

		Ambient Air Temperature (°C)																								
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125
Load (t)	1.8	52	54	57	59	62	64	66	69	71	73	75	78	80	82	85	87	89	92	94	97	99	101	104	106	109
	2.6	55	58	60	62	65	67	69	72	74	76	79	81	83	86	88	90	93	95	97	100	102	105	107	109	112
	7.3	59	61	63	66	68	70	73	75	77	80	82	85	87	90	92	94	97	99	102	104	106	109	111	114	117
	9	60	62	65	67	69	72	74	76	79	81	83	86	88	91	93	95	98	100	102	105	107	110	112	114	117
	10.8	61	63	66	68	70	73	75	78	80	82	85	87	90	92	94	97	99	102	104	106	109	111	114	116	118
	12.6	62	65	67	69	71	74	76	79	81	84	86	88	91	93	96	98	100	103	105	108	110	112	115	117	120
	14.4	63	66	68	70	73	75	77	80	82	85	87	89	92	94	97	99	102	104	106	109	111	114	116	118	121
	16.2	64	67	69	71	74	76	79	81	83	86	88	91	93	95	98	100	103	105	107	110	112	115	117	119	122
	18	66	68	70	73	75	77	80	82	85	87	89	92	94	97	99	101	104	106	109	111	114	116	118	121	123
	19.8	67	69	71	74	76	78	81	83	86	88	91	93	95	98	100	103	105	108	110	112	115	117	120	122	124
	21.6	68	70	73	75	77	80	82	84	87	89	92	94	97	99	101	104	106	109	111	114	116	118	121	123	126
	23.4	69	71	74	76	78	81	83	86	88	90	93	95	98	100	103	105	108	110	112	115	117	120	122	125	127
	25.2	70	73	75	77	79	82	84	87	89	92	94	97	99	101	104	106	109	111	114	116	119	121	123	126	128
	27	71	74	76	78	80	83	85	88	90	93	95	98	100	103	105	108	110	113	115	117	120	122	125	127	129
	28.8	73	75	77	79	82	84	87	89	92	94	96	99	101	104	106	109	111	114	116	119	121	123	126	128	131
	30.6	74	76	78	81	83	85	88	90	93	95	98	100	103	105	108	110	113	115	118	120	122	125	127	130	132
	32.4	75	77	80	82	84	87	89	92	94	97	99	102	104	107	109	112	114	117	119	121	124	126	129	131	133
	34.2	77	79	81	83	86	88	91	93	96	98	101	103	106	108	111	113	116	118	121	123	126	128	130	133	135
36	78	80	83	85	87	90	92	95	97	100	102	105	107	110	112	115	117	120	122	125	127	130	132	134	137	



# Trim Calculator

## Load Line Characteristics and user defined operating point

### Step 1: Model Selection

### Step 2: User Inputs

DCM Trim Calculator

Select filter    Select filter    Select filter    Select filter    Select filter

Reset Filters

Vin (V)	Vout (V)	Power (W)	Package	Optimized For	Part Number
24	5	180	3623 ChiP	Array	DCM24AP050x180A50
24	12	320	3623 ChiP	Array	DCM24AP120x320A50
24	15	320	3623 ChiP	Array	DCM24AP150x320A50
24	24	320	3623 ChiP	Array	DCM24AP240x320A50
24	28	320	3623 ChiP	Array	DCM24AP280x320A50
24	36	320	3623 ChiP	Array	DCM24AP360x320A50
24	48	320	3623 ChiP	Array	DCM24AP480x320A50
28	3.3	120	3623 ChiP	Array	DCM3623x50M04A2y0z
28	3.3	120	3623 ChiP	Standalone	DCM3623x50M04A2y7z
28	5	180	3414 VIA	Standalone	DCM3414x50M06A8yzz
28	5	180	3623 ChiP	Array	DCM3623x50M06A8y0z
28	5	180	3623 ChiP	Standalone	DCM3623x50M06A8y7z
28	12	320	3414 VIA	Standalone	DCM3414x50M13C2yzz
28	12	320	3623 ChiP	Array	DCM3623x50M13C2y0z
28	12	320	3623 ChiP	Standalone	DCM3623x50M13C2y7z
28	15	320	3414 VIA	Standalone	DCM3414x50M17C2yzz
28	15	320	3623 ChiP	Array	DCM3623x50M17C2y0z
28	15	320	3623 ChiP	Standalone	DCM3623x50M17C2y7z
28	24	320	3414 VIA	Standalone	DCM3414x50M26C2yzz
28	24	320	3623 ChiP	Array	DCM3623x50M26C2y0z
28	24	320	3623 ChiP	Standalone	DCM3623x50M26C2y7z
28	28	320	3414 VIA	Standalone	DCM3414x50M31C2yzz
28	28	320	3623 ChiP	Array	DCM3623x50M31C2y0z
28	28	320	3623 ChiP	Standalone	DCM3623x50M31C2y7z
28	48	320	3414 VIA	Standalone	DCM3414x50M53C2yzz

1.524" (38.72 mm)    0.898" (22.8 mm)    0.284" (7.21 mm)

Part Number DCM24AP050T180A50 »

Package 3623 ChiP

Input Voltage 24 (18.0 to 36.0) V

Output Power 180 W

Product Grade T

Array Count 1 Maximum 8

Required Output Voltage 5 5.0 (4 to 5.5) V

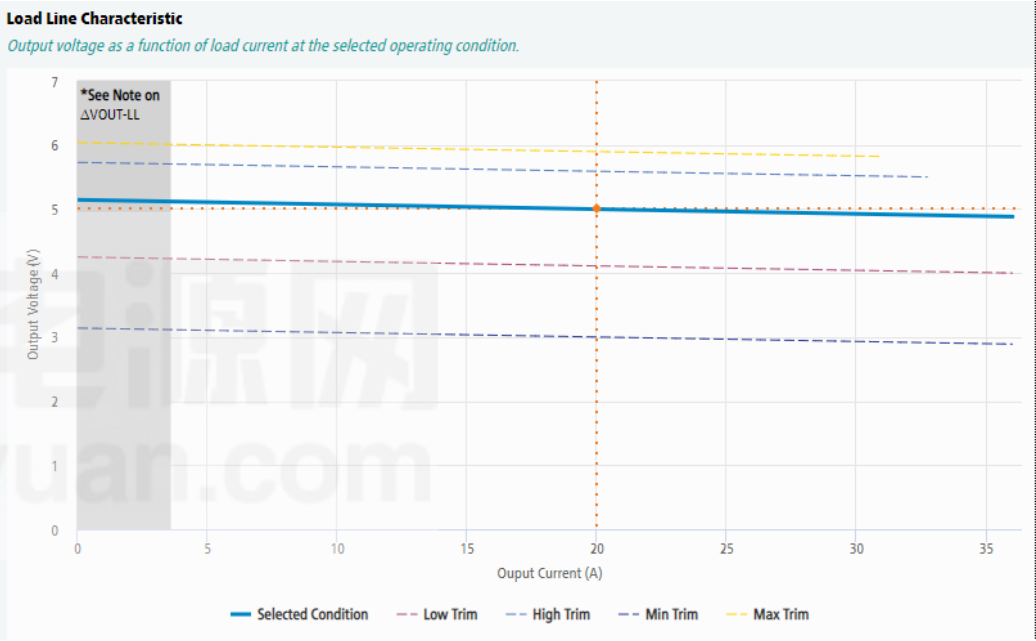
Output Current 20 36 A

Operating Temperature 25 -40 °C to 125 °C

Trim Pin Voltage ( $V_{TR}$ ) 2.146 V

Trim Resistor ( $R_{TRIM}$ ) 18.6 k $\Omega$

Data Sheet » Analyze >



### Trim Resistor Calculations

# Vicor Online Tools

Tools and references to select, architect and implement power systems

## Whiteboard

Architect your power system through analysis of topology and efficiency

**OPEN**

## Simulators

Precision modeling of electrical and thermal behavior of Vicor products

**OPEN**

## Calculators

Guidance for determining accessory components for your power design

**OPEN**



# Useful Vicor Website Links

DCM™ DC-DC Converter Module Product Family

[www.vicorpower.com/dc-dc/isolated-regulated/dcm](http://www.vicorpower.com/dc-dc/isolated-regulated/dcm)

DCM Design guide

[http://www.vicorpower.com/documents/design\\_guides/DG-DCM-Design-Guide-VICOR.pdf](http://www.vicorpower.com/documents/design_guides/DG-DCM-Design-Guide-VICOR.pdf)

DCM Trim Calculator

<http://spicewebprd.vicorpower.com/apps/dcmTrimCalculator/Calculator.php>

Thank you