

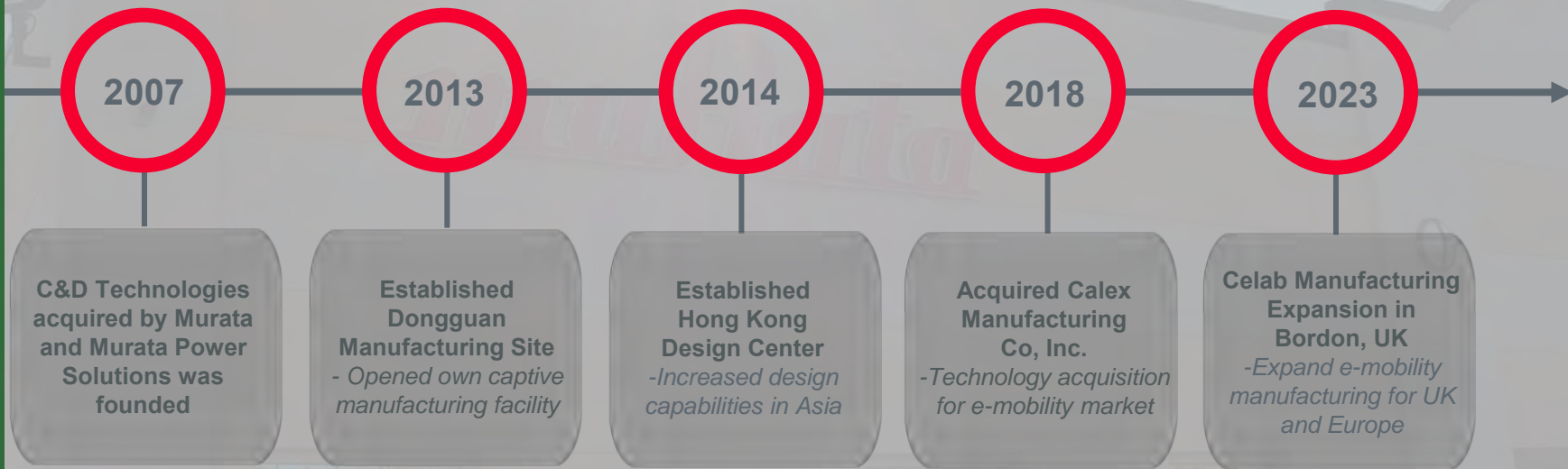


Murata MPS Calex Product Portfolio

September 2024

CALEX

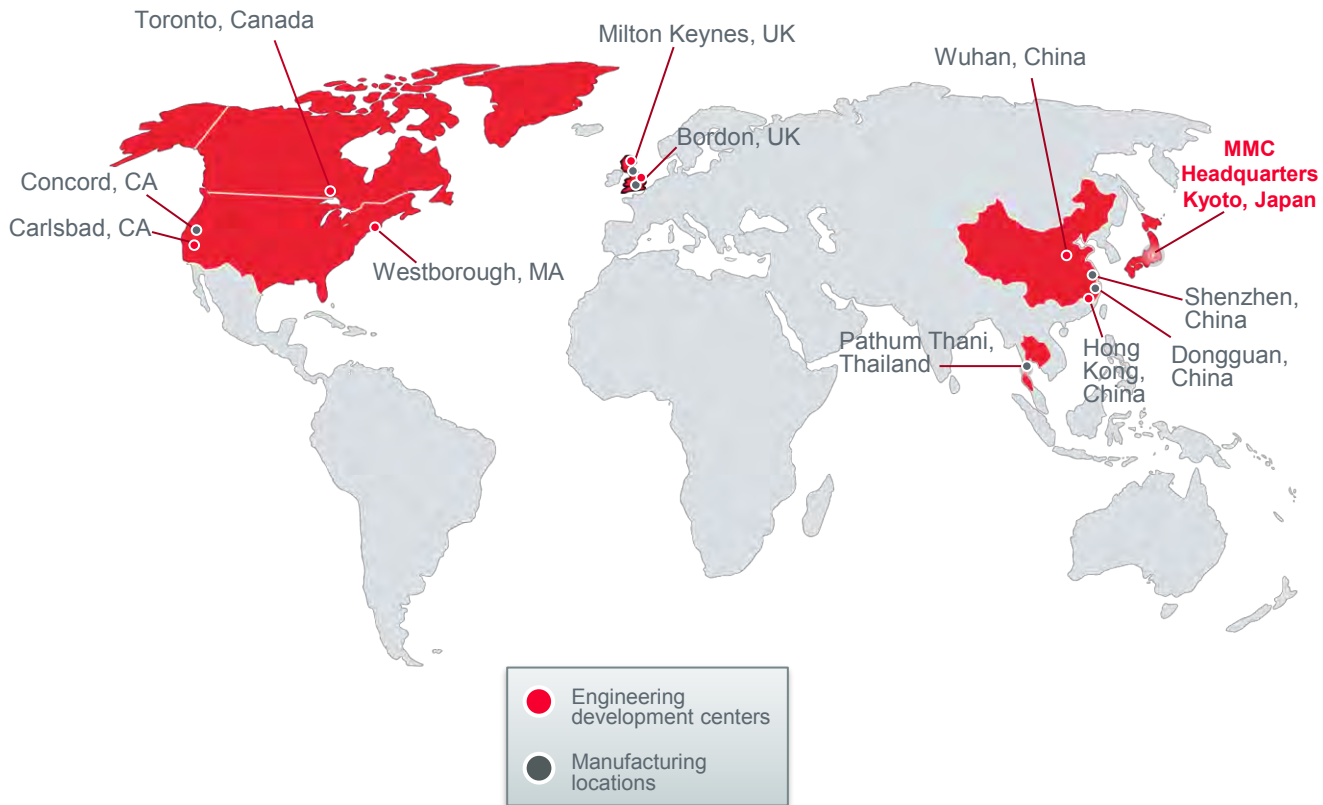
Our History



Murata Power Solutions

Worldwide leader in the design and manufacturing of AC-DC and DC-DC power converters.

Focused in the industries of server, storage, networking (SSN), e-mobility, autonomous tech, and the emerging artificial intelligence (AI) markets.



2007

Murata Power Solutions established

1,000+

employees worldwide

7

engineering development centers

6

manufacturing locations

Mission

We contribute to a green planet by developing leading edge power conversion products that enable advanced technologies

Vision

We power technologies of the future

Our Strategic Goals

We offer best in class, highly efficient power conversion products that support a sustainable future

Megatrends

Server, Storage, and Networking

Megatrends

E-Mobility & Autonomous Technology

Shaze

Our Philosophy

Quality high performance

Employee and customer satisfaction



Main Markets & Applications

Data Centers

Racking up power for server, storage, & networking applications



Cloud Computing



Cyber Security



5G



Edge Computing



Artificial Intelligence

E-Mobility

Powering the next generation of e-mobility



Battery Charging



Commercial Trucks



Marine



RV



Autonomous Delivery Robots

Industrial, Robotics, & Medical

Enabling the future of automation



Robotics



Factory Automation



Outdoor Signs & Displays



Vending Machines



Hospital Beds

We contribute to the advancement of society with leading-edge technology that powers the future with sustainable energy solutions

Innovative Technologies



Wide band gap technology integration
-improved efficiency and power density



Totem pole power factor correction
-reduced packaging size and improved efficiency



Liquid cooling systems
-e-mobility, harsh environment operation, reduced size and weight



Friction mechanical stir welding
-reduction in mechanical hardware, efficient manufacturing



Integrated control firmware
-communication / interface with the existing vehicle system

Our Operations



Research & Development

Industry leading expertise in developing innovative power technology



Manufacturing

Over 23 million power supplies manufactured every year in our 6 manufacturing locations throughout North America, Asia, and Europe



Quality Management Systems

Management & employees are committed to continual improvement

Certifications:

- ISO 9001
- IATF19649
- ISO 14001

Rugged Environment - Power, What Matters?

- **How Much Power is required**

- What is the required output power or Current
- Is the power requirement continuous/stable or are there any peaks/ or surges?

- **Mechanics**

- Are There any dimension constraints?
- How will the PSU be mounted (Chassis, onboard)

- **EMI/EMC**

- Are there any standards that apply or are required?

- **Isolation**

- Does the power supply require input to output isolation?

- **Safety Standards**

- Is a requirement for any Specific standards (Medical, Rail, Consumer, ICT)?

- **Input and Output**

- What is the input voltage window?
- What is the output Voltage window?

- **Environment**

- **Thermals**

- Will there be air flow and if so, how much?
- What is the operating temperature?
- How will the power supply be mounted
- How clean is the air

- **Shock and Vibration**

- Low vibration application or onboard or road/trackside

- **Reliability**

- downtime cost Vs Capex cost
- Cost and ease to replace



Murata Calex Portfolio - AC-DC & DC-DC Converters



Range of Brick solutions up to 1000W DC-DC Converter (FXW)



300W Charger (CEV) and 250W Power Supply (LHC)



Chassis Mount DC/DC Converters from 40 Watts to 3500 Watts



600W AC-DC Power Supply (IHC)



240W Onboard Charger (LPE)



BCA/BCE Series Bi-directional DC-DC 3kW Converters

Our Competitive Advantages

- Highest power density in the industry
- Efficiencies up to 97%
- Wide input ranges up to 10:1
- 50W to multi kW output capability
- Ruggedized designs
- Value-added designs
- ISO 9001:2015 certified
- EN50155 qualified for rail
- IATF certified factories
- Manufacturing in USA and UK
- Engineering and design centers in the USA and UK
- Premium brand!



Target Applications



E-Mobility



Industrial



Medical



Rail



Robotics



Material Handling

Products For E-mobility Overview

APU's

BCA Series

6 - 18VDC Input (LS), 24 - 58VDC
Output (HS) 3000 Watts
Bi-Directional Converter



Production Released



HBC Series

Bi-Directional DC/DC
800/400V I/P to 24/12V O/P VDC at 4kW
IP Rated Enclosure

Released Samples Available

BCE Series

6 - 18VDC Input (LS), 24 - 58VDC
Output (HS) 3000 Watts
Bi-Directional Converter



Samples Available



Samples Available

HVC Series

Onboard DC/DC
400 I/P to 12 O/P VDC at 3kW
IP Rated Enclosure

OBC's

6.6kW OBC Series

Single Phase (AC) Onboard Charger
230VAC I/P to 400VDC O/P at 6.6kW
IP Rated Enclosure



Samples Available



In Design

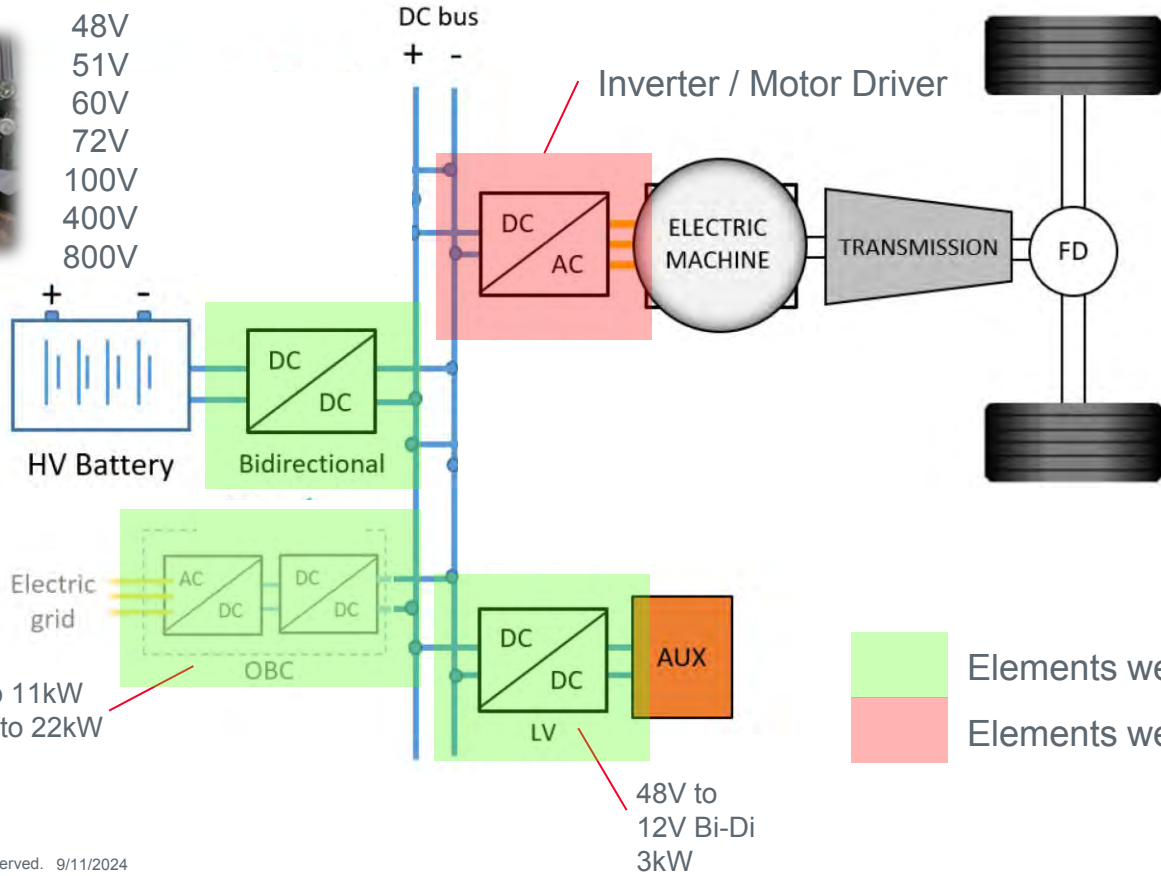
22kW OBC Series

Three Phase Onboard Charger
3Ph to 400VDC or 800V O/P at 22kW
Liquid cooled

E-Mobility Application Example



- 48V
- 51V
- 60V
- 72V
- 100V
- 400V
- 800V



Elements we can supply
 Elements we don't supply

48V to 12V Bi-Di
3kW



Products For Rail Overview

- Standard brick size DC-DC converters (1/16 to Full Brick and 1x1" to 1x2" size)
- Single output modules from 5V to 57VDC
- 9V - 36Vin; output power from 15W to 1000W
- 18V - 75Vin and 57V - 160Vin; output power from 10 to 250W
- 16 - 160V (10:1) Vin range covers all traction batteries in ONE part Convection cooled (no fan) from -40°C up to 85°C ambient & up to 110°C case temperature
- Fully regulated outputs optimized for harsh industrial railway environments applications in harsh environments
- Chassis mount
- Value add solutions



Target Customers For Rail

SIEMENS

WABCO
Mobilizing Vehicle Intelligence

STADLER

 GE Transportation

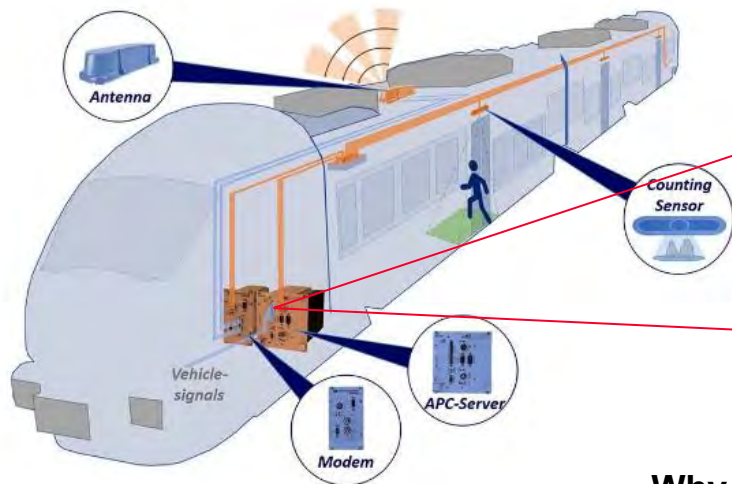
ALSTOM

CAF

Progress Rail
A Caterpillar Company

CALEX

Rail Application Example



Why this application is a good fit...

- Meets requirements for EN50155
- Encapsulated for harsh environment
- 4242VDC input to output reinforced isolation
- Wide input voltage range

<https://www.interautomation.de/en/products/automatic-passenger-counting-apc>

Target customers

- Eurotech
- Dilax
- Icomera



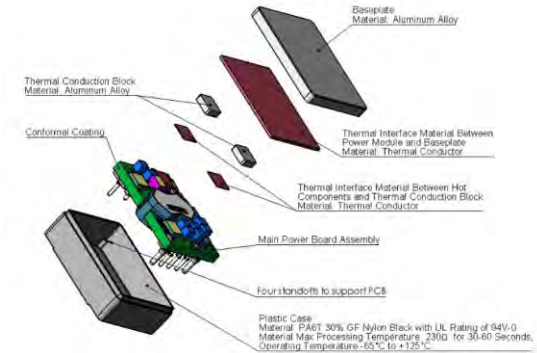
Products Overview - Railway & Transport

- Standard brick size DC-DC converters (1/16 to Full Brick and 1x1" to 1x2" size)
- Single output modules from 5V to 57VDC
- 9V – 36Vin; output power from 15 to 1kW
- 18V – 75Vin and 57V – 160Vin; output power from 10 to 250W
- 16V – 160Vin; output power from 150 to 300W
- Convection cooled (no fan) from -40°C up to 85°C ambient & up to 110°C case temperature
- Designed for rugged industrial applications in harsh environments
- Chassis mount and DIN-rail version
- Value add solutions



Our Advantages - Railway & Transport

- Designed for the most demanding environments and applications
- Use of latest technology and most efficient architectures for power conversion
- Extensive EVT/DVT test and evaluation
- Widest input ranges with the most power
- Modules meet the relevant Railway Standard requirements per EN50155 (2017)
- Single block aluminum machined baseplates
- Thermal interface materials are of the highest quality and thermal conductivity
- Excellent thermal performance for -40°C to +105°C Tb range
- Plastic components are made from engineered plastics with temp ratings >300°C



Products For Industrial Overview

- Standard brick size DC-DC converter offering (1/16 to Full Bricks)
- Chassis mount and DIN-rail version
- 9 - 36V and 18 - 75VDC wide input ranges
- Single output modules from 5V - 57VDC
- Output power range from 3W - 1kW
- Convection cooled (no fan) from -40°C up to 85°C ambient & up to 110°C case temperature
- Designed for rugged industrial applications in harsh environments
- Value add solutions



Target Applications & Customers For Industrial

- Test & measurement
- Motor drive systems
- Welding, laser cutting/edging
- Industrial communications
- Process & control systems
- Instrumentation
- Factory automation
- Outdoor signs & displays
- Lightning, stage lighting
- Outdoor broadcast
- Pharmaceutical incubation
- Elevator controls



ABB

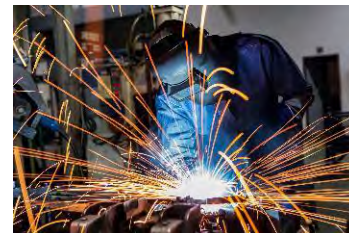
Honeywell



NOKIA



Fronius



Products For Robotics Overview

- 1000 Watt Full Bricks
 - 9 - 36VDC & 18 - 75VDC inputs
 - 12, 24, 28, 48, 53 VDC outputs
 - Efficiency up to 96%
- 500 Watt Half Bricks
 - 9 - 36VDC
 - 12, 24, 28VDC outputs
 - Efficiency >95%
- 360 Watt Half Bricks
 - 9 - 36VDC
 - 12, 24, 28VDC outputs
 - Efficiency >95%
- 250 Watt Quarter Brick
 - 9 - 36VDC
 - 12VDC output
 - Efficiency up to 93%



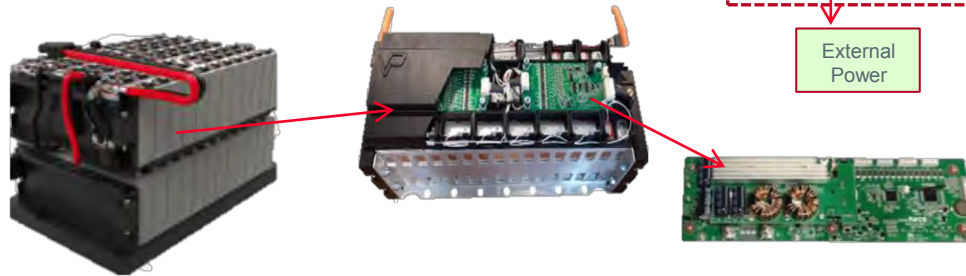
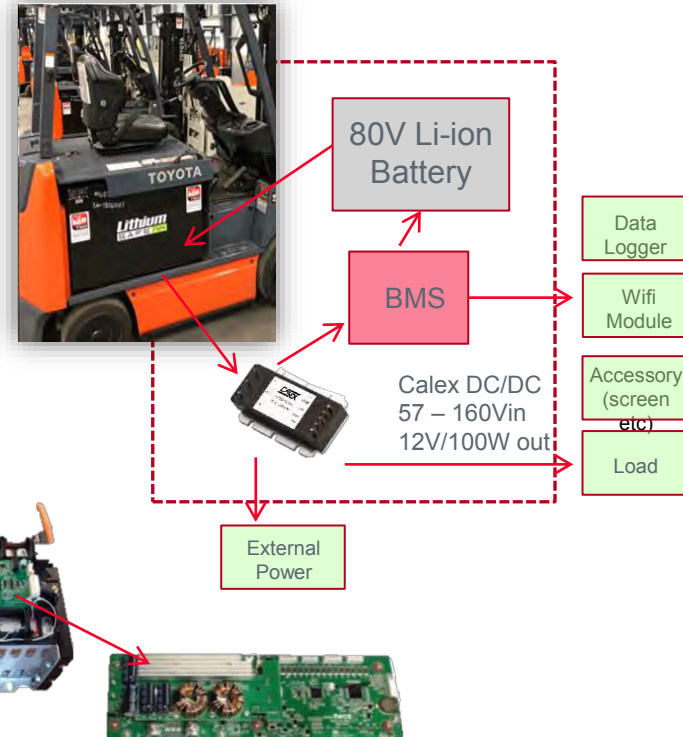
Target Applications For Robotics

- Delivery robots
- Industrial robots
- Inventory control
- Special task robots
- Manufacturing robots
- Drones
- Forklifts



Battery Management Systems Overview

- Basic function of a battery management system
- Typical application → Forklift
- The DC/DC converter provides input - output isolation, which powers the BMS, external peripherals & external power
- Typical Li-ion battery pack with battery voltages from 24V to 110V
- Battery pack - includes batteries & controller with internal DC-DC converter



Products For Battery Management Systems Overview

- Standard brick size DC-DC converters (1/16 to Full Brick and 1x1" to 1x2" size)
- Single output modules from 5V - 57VDC
- 9V - 36Vin; output power from 15 - 1kW
- 18V - 75Vin & 57V - 160Vin; output power from 10 - 250W
- 16V - 160Vin; output power from 150 - 300W
- Convection cooled (no fan) from -40°C up to 85°C ambient & up to 110°C case temperature
- Designed for rugged industrial applications in harsh environments
- Chassis mount and DIN-rail version
- Value add solutions



Target Customers For Battery Management Systems

- Battery system integrators
- Battery manufacturers
- BMS manufacturers
- Agriculture, forestry and construction vehicles
- Forklifts, cherry pickers and utility vehicles
- AGV (automated guided vehicles)
- Energy distribution
- Motor drive systems
- Marine



Competitive Advantages



- ▣ Highest power density in the industry
- ▣ Efficiencies up to 97%
- ▣ Ruggedized designs
- ▣ Value-added designs
- ▣ ISO 9001:2015 certified
- ▣ IATF certification
- ▣ IP rated designs
- ▣ CAN Communication



Product Types

- Large offering of DC-DC converters
- Power range
 - Up to 4 kW (16kW paralleled)
- Topologies:
 - Bi-Directional
 - Buck
 - Boost
- Configurations
 - Chassis Mount
 - Liquid Cooled
 - Air Cooled



1500 W Bi-directional BCA Series

Optimized for micro and mild hybrid e-Mobility power applications

- e-Mobility 48V/12V battery systems
- Disconnect switch on LS (12V)
- Constant voltage and constant current model
- LS current and internal temperature monitoring
- High power density
- Efficiency up to 97%
- Overcurrent, overvoltage, & over-temperature



Model Number	V in Nominal	Vin Range	V out Nominal	V out Range	Case Size
48S12.1K5BCA	48	24-58	12	6 – 18	5.25" x 5.50" x 1.0"



3000 W Bi-directional BCA Series

Optimized for micro and mild hybrid e-Mobility power applications

- e-Mobility 12V/48V, 24/48, 28/48 battery systems
- Disconnect switch on LS (12V)
- Constant voltage and constant current model
- LS current and internal temperature monitoring
- High power density
- Efficiency up to 97%
- Overcurrent, overvoltage, & over-temperature protection All protections



Model Number	V in Nominal	Vin Range	V out Nominal	V out Range	Case Size
48S12.3K0BCA	48	24-58	12	6 – 18	9.4" x 5.4" x 1.0"
48S24.3K0BCA	48	24-58	24	18 – 30	9.4" x 5.4" x 1.0"



3000 W Bi-directional BCE Series

- IP Rated Enclosures
- Air and Liquid cooled version
- E-Mobility 12V/48V, 24/48, battery systems
- Disconnect switch on LS (12V)
- Constant voltage and constant current model
- LS current and internal temperature monitoring
- High power density
- Efficiency up to 97%
- Overcurrent, overvoltage, & over-temperature protection



Model Number	V in Nominal	Vin Range	V out Nominal	V out Range	Case Size
48S12.2150BCE	48	24-58	12	6 – 18	9.7" x 9.8" x 2.0"
48S24.107K0BCE	48	24-58	24	18 – 30	9.7" x 9.8" x 2.0"
24S12.215BCE	24	18-30	12	6-18	9.7" x 9.8" x 2.0"



3000W HVC Series

Optimized for e-mobility auxiliary power applications

- E-Mobility 400V/12V battery systems
- Wide 230-420 VDC input range
- IP6K9K Ingress protection
- High power density
- Efficiency up to 94%
- Overcurrent, overvoltage, & over-temperature protection
- SAE J1939 protocol via CAN Bus Interface



Model Number	V in Nominal	V in Range	V out Nominal	V out Range	Case Size
400S12.3K0HVC-L	400	230-420	12	9-16	10.5" x 9.4" x 2.3"
400S12.3K0HVC-A	400	230-420	12	9-16	10.5" x 9.4" x 2.8"



4000 W High Voltage Bi-directional HBC Series

- IP Rated Enclosures
- Liquid cooled
- E-Mobility 400V and 800V battery systems
- 12Vdc and 24Vdc outputs
- Constant voltage and constant current model
- High power density
- Efficiency up to 96%
- Overcurrent, overvoltage, & over-temperature protection



Model Number	V in Nominal	Vin Range	V out Nominal	V out Range	Case Size
400S12.4K0HBC	400	220-450	12	8-16	14" x 8" x 3"
400S24.4K0HBC	400	220-450	24	16-32	14" x 8" x 3"
800S12.4K0HBC	800	440-875	12	8-16	14" x 8" x 3"
800S24.4K0HBC	800	440-875	24	16.32	14" x 8" x 3"



Agricultural Vehicle Market Segment



Autonomous Tractor:

Calex DC/DC converter powers the Intermediate Power-bus which powers loads such as computers, communication equipment, sensors, and lights.



EV Tractor & Farm Equipment:

Calex DC/DC converter powers the Intermediate Power-bus which powers loads such as computers, communication equipment, sensors, and lights. Can power sensors & motors on farm equipment as well.



Heavy Truck Market Segment



Heavy Truck: DC/DC converter
Calex DC/DC converter can power auxiliary power nets that provide power to Non-essential loads.



Heavy Truck: Battery Equalizer
The Calex Battery Equalizer equalizes the charge and discharge currents between 12Vdc batteries that are used to create the 12Vdc Bus and the 24Vdc bus.
If the equalizer fails, then the vehicle can still be driven but battery life is adversely affected.



Construction Vehicle Market Segment

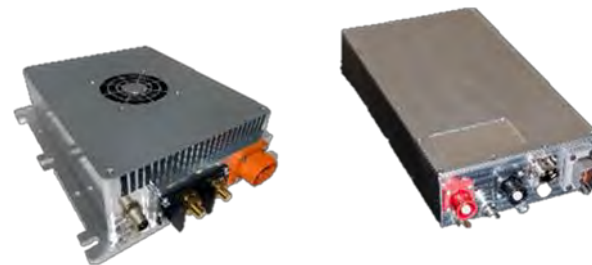


EV Construction Equipment:

Calex DC/DC converter powers the Intermediate Power-bus which powers loads such as computers, communication equipment, sensors, and lights. Hydraulic systems are typically 50% efficient.

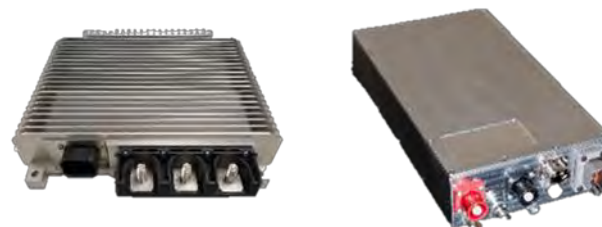
Switching

To electric drive screw technology will improve over all efficiency.



EV Construction Equipment:

Calex DC/DC converter powers the Intermediate Power-bus which powers loads such as computers, communication equipment, sensors, and lights. Hydraulic systems are typically 50% efficient. Switching
To electric drive screw technology will improve over all efficiency.



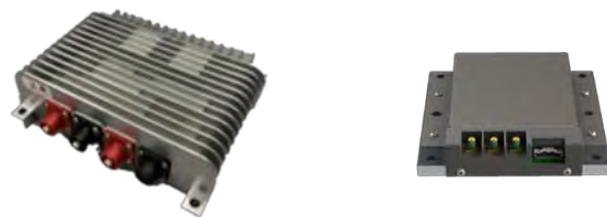
After Market Recreational Vehicle Market Segment



Energy Storage System:
Extra batteries are installed and are charged by the Calnex product while the engine is running. When the engine stops the Calnex product transfers energy from the storage batteries to the main battery.



Energy Storage System:
Extra batteries are installed and are charged by the Calnex product while the engine in the tow vehicle is running. When the engine stops the Calnex product transfers energy from the storage batteries to the main trailer battery.



After Market Marine Market Segment



Energy Storage System:
Extra batteries are installed and are charged by the Calex product while the engine is running. When the engine stops the Calex product transfers energy from the storage batteries to the main battery.



Energy Storage System:
Extra batteries are installed and are charged by the Calex product while the engine is running. When the engine stops the Calex product transfers energy from the storage batteries to the main battery.



After Market Anti-Idling Market Segment



Anti-Idling: Emergency Vehicles

Calex DC/DC converter powers the Essential loads once the engine is shut-off. Once the vehicle's engine is started the alternator resumes powering the loads. This is done to lower emissions while the vehicle is parked and needs to power loads.



Anti-Idling: Refrigerated Delivery Vehicles

Calex DC/DC converter powers the Refrigeration loads once the engine is shut-off. Once the vehicle's engine is started the alternator resumes powering the loads. This is done to lower emissions while the vehicle is parked and needs to power the refrigeration system.



Refrigeration Vehicle Market Segment



Refrigerated Cargo Vehicles:
Calex DC/DC converter powers the refrigeration unit on the cargo box.



Refrigerated Semi-Trailers:
Calex DC/DC converter powers the Under-trailer power system that powers the refrigeration unit on the front of the trailer.



Thank You!

