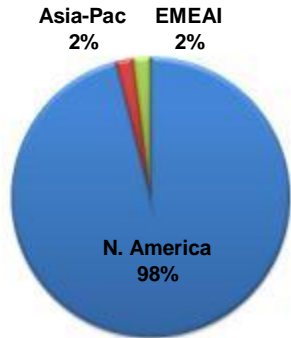


DC to DC Converters and Battery Equalizers



Regional Rev.



Key Customers



Accelerating Development; Driving Solutions

- Positioned well to further penetrate Global OEMs
- High-growth applications driving business recovery in 2010
- Investing in Control Electronics portfolio with smarter, higher value devices



OMNEX
TRUSTED WIRELESS™



Targeting high-growth applications with smarter, higher value solutions

Strong Relationships with Leading OEMs



A large yellow arrow pointing downwards, containing the text "Power Distribution".

Power Distribution

A large blue arrow pointing downwards, containing the text "Power Conversion".

Power Conversion

A large red arrow pointing downwards, containing the text "Circuit Protection".

Circuit Protection

A large green arrow pointing downwards, containing the text "Wired & Wireless Control".

Wired & Wireless Control

A large orange arrow pointing downwards, containing the text "Battery Management".

Battery Management

A wide, grey rectangular box with a black border, containing the text "Truck, Military, Con/Ag, Marine, RV, Bus, Hybrid, Distribution".

Truck, Military, Con/Ag, Marine, RV, Bus, Hybrid, Distribution

A white rectangular box with a black border, containing the text "Drive global product and technology roadmaps".

Drive global product and technology roadmaps

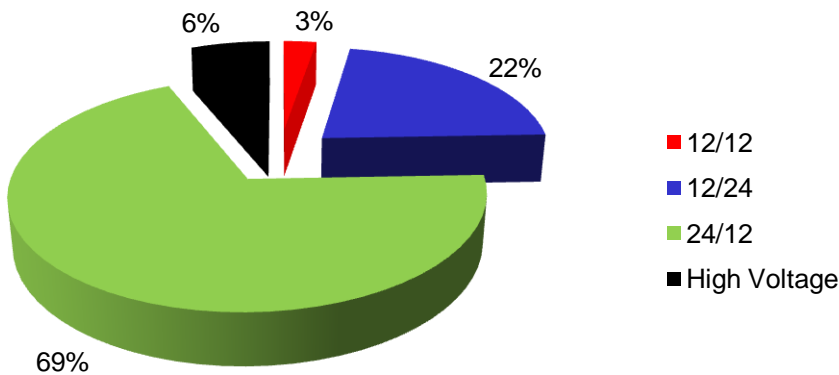
Sure Power Brand Products



Controls and Power Management

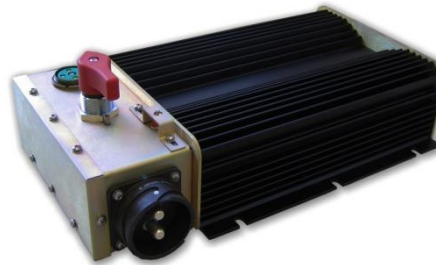


2009 Power Conversion Sales



Product Focus

- Vehicle based power conversion
- DC to DC Converters and Battery Equalizers
- Rugged power supplies
- 12V to 72V inputs
- 12V – 36V output
- Output power 10W to 1500W



55% of Power Conversion outputs exceed 500W and 45% over 1KW

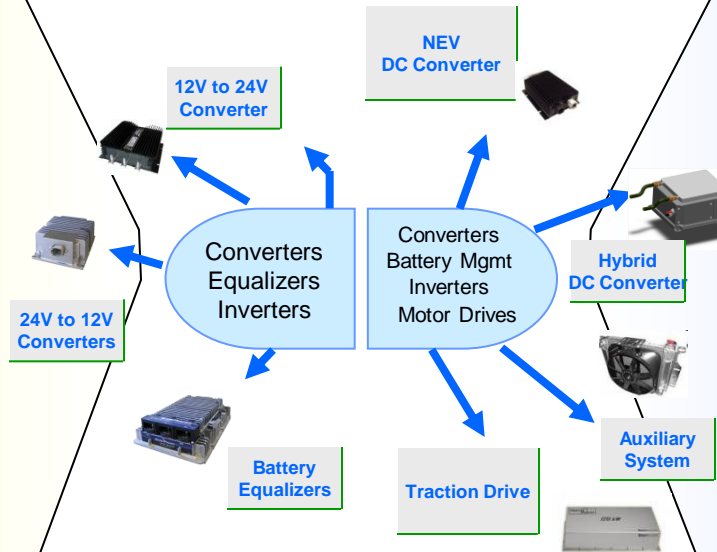
Strengths	Opportunities
<ul style="list-style-type: none"> ■ Brand recognition and Industry reputation <ul style="list-style-type: none"> ✓ Strong with OEM's and Fleets in US, growing in Asia ✓ Direct Technical Sales ■ Application Experience and Responsiveness <ul style="list-style-type: none"> ✓ Customized high power conversion solutions ■ Established OEM supplier performance <ul style="list-style-type: none"> ✓ Daimler, Paccar, International, Harris, Caterpillar, Deere ■ Ruggedized packaging, robust electronics <ul style="list-style-type: none"> ✓ Not backed by IP, but not easy to replicate 	<ul style="list-style-type: none"> ■ Lead transformation to dual voltage solutions <ul style="list-style-type: none"> ✓ Class 5 – 8 Trucks, global Battery Equalizer ■ Broaden product portfolio – HV DC, Inverters <ul style="list-style-type: none"> ✓ OEM's moving towards ruggedized inverters, U.S. and EU ✓ Lead development of DC converters for HD Hybrids ■ Europe and Asia <ul style="list-style-type: none"> ✓ Continue to build upon globalization of OEMs and chassis ✓ Cost reduced power conversion platforms (L&T source?) ■ Military Power Supplies <ul style="list-style-type: none"> ✓ Largest existing TAM
Weaknesses	Threats
<ul style="list-style-type: none"> ■ Global presence, especially EU ■ Existing product breadth <ul style="list-style-type: none"> ✓ Niche applications, high mix ■ Manufacturing Cost <ul style="list-style-type: none"> ✓ Low automation, high cost labor, early stages of lean ■ Engineering Depth ■ Cost Reduction ■ Formal Technology Roadmaps 	<ul style="list-style-type: none"> ■ Entrance of automotive suppliers <ul style="list-style-type: none"> ✓ Chasing higher growth, higher prices, higher margins ■ EU and Asia local suppliers entering <ul style="list-style-type: none"> ✓ Bosch, Delphi, Denso, Hella ■ Price pressure as volumes grow ■ Evolving markets, evolving needs <ul style="list-style-type: none"> ✓ Specification moving targets

Low Voltage Commercial Vehicles

- **Class 5 – 7 Medium Duty**
 - 12V U.S.
 - 24V EU
- **Class 8 Heavy Duty**
 - 12V U.S.
 - 24V EU
- **Construction**
 - 24V Heavy
 - 12V Light
- **Agriculture**
 - 12V system with 24V starting Heavy
 - 12V Light
- **Specialty Vehicle**
 - 24V Bus
 - 12V Work Trucks

High Voltage Commercial Vehicles

- **Neighborhood EV**
 - Golf Carts
 - Low Speed EV (Gemcar)
 - Municipal
- **Hybrid**
 - Bus
 - Truck
- **Auxiliary Systems**
 - Ref
 - HVAC
 - Electrification of belt driven loads



Includes both DC Converters and Battery Equalizers up to 48V

Market Drivers:

- Fuel Economy (Reduce efficiency losses, eliminate idling)
- Globalization (Use of global components on regional trucks)
 - Radios and accessories predominantly 12V driven by automotive volumes
- Increasing creature comfort (Load capacity reaching limits of 12V systems)
- Emissions Regulations (Making engines more difficult to start and requiring more power)
 - Heavier loads due to selective catalytic reduction (SCR) system



Existing Market Opportunities:

- Global Battery Equalizer (Powering 12V fuel injectors and body loads on 24V vehicle)
- Battery Equalizer for 24V conversion of vehicles (Ryder testing due to difficulty starting engines)
- Electrification of HVAC Systems (Thermo King Tri Pak System, 24V battery powered HVAC)
- Golf / Utility Vehicle Market (Electric drives will proliferate as people look to reduce fuel use)



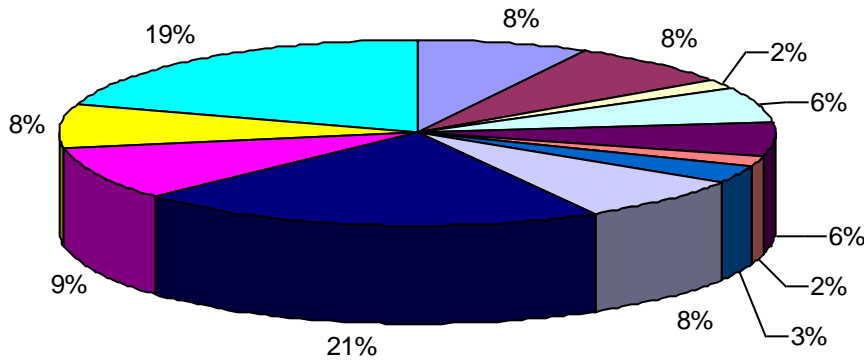
Future Market Opportunities:

- Global 24V truck with 12V requirements
- Further electrification of traditionally belt driven loads (Water pump, HVAC, Cooling Fans)
- Low Speed neighborhood electric vehicle (NEV), 48V or 72V





Non Automotive DC Converter Market

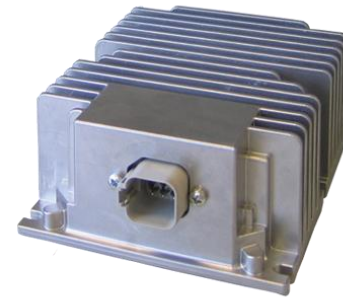


- Vanner
- Actia
- Axiomatic
- Webber
- Autolive
- Acquis
- New Era
- Martek
- Sure Power
- Bosch
- Hella
- other

	Est Rev 2009
Vanner	\$ 5,000
Actia	\$ 5,000
Axiomatic	\$ 1,000
Martek	\$ 5,000
Webber	\$ 4,000
Autolive	\$ 4,000
Acquis	\$ 1,000
New Era	\$ 2,000
Sure Power	\$ 14,000
Bosch	\$ 6,000
Hella	\$ 5,000
other	\$ 13,000
	\$ 65,000

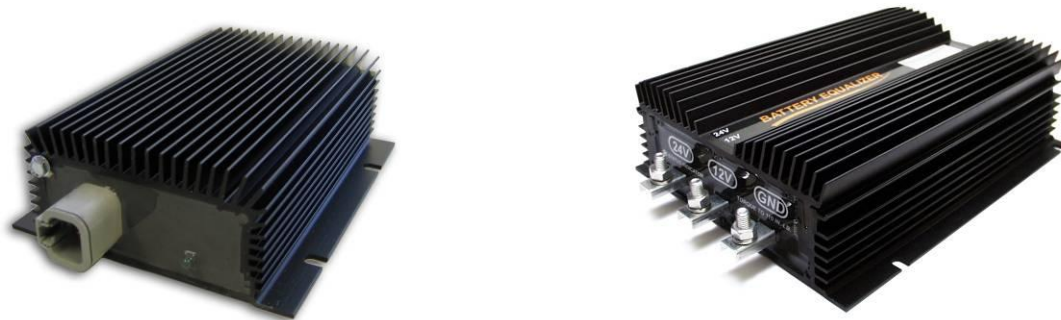
Leadership position in ruggedized 12/24V converters from 5 – 100A

- **DC-DC Step Up Converter**
- **DC-DC Step Down Converter**
- **Battery Equalizer**
- **Future Developments**

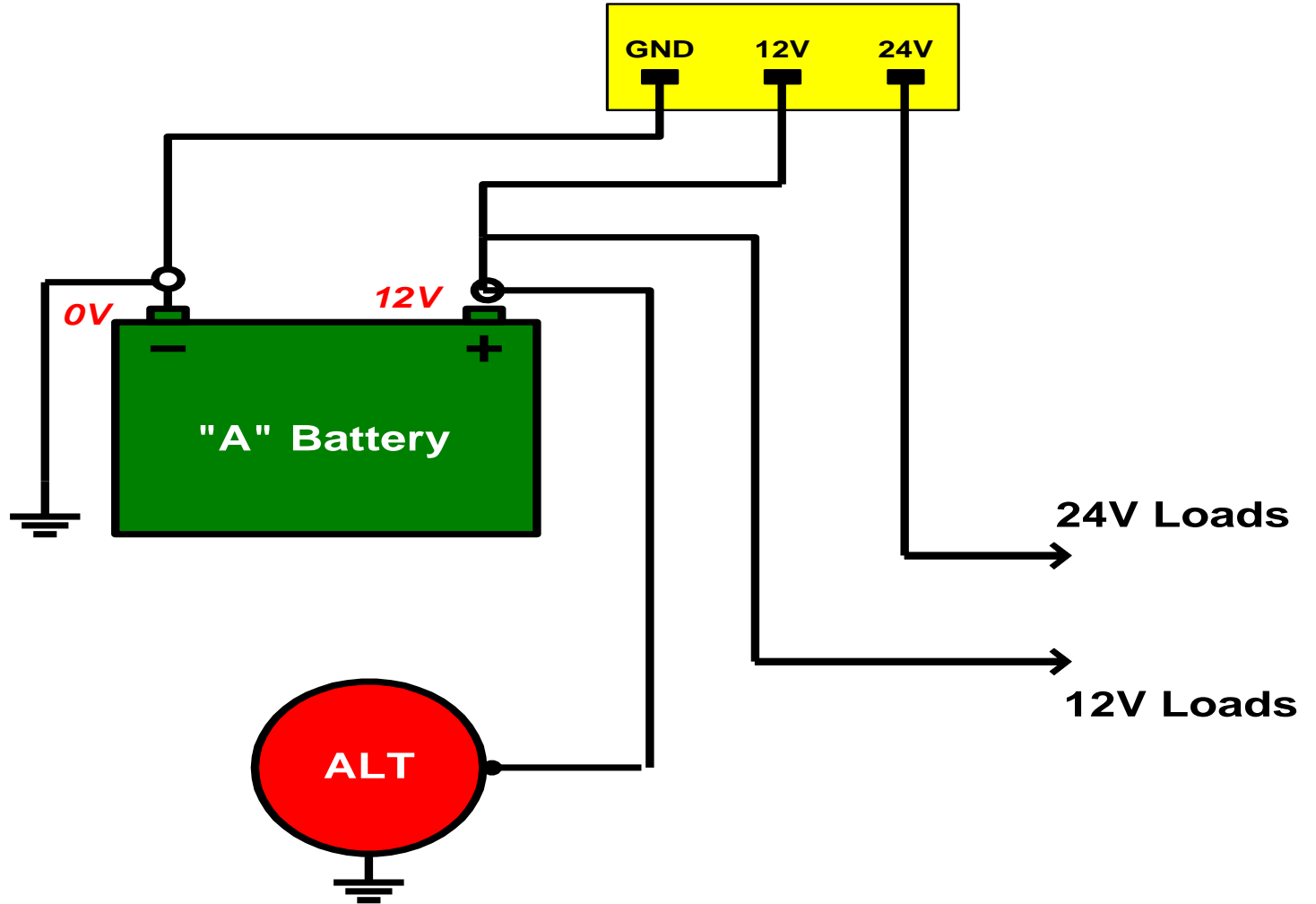


- **Many heavy duty vehicles now operate on 24V, and yet still have a 12V requirement for radios, lights, controls etc.**
- **Many 12V vehicles have a need for 24V appliances or accessories**

- **Commonly used**
 - North American Truck Market
 - Commercial Vehicle used in Military Application
- **Output voltage is fixed**
- **Voltage is stepped up to power 24V loads up to approximately 1100W**



12V-24V Boost DC-DC Converter



Advantages

- **Simple to**
 - Implement
 - Wire
 - Understand
- **Reliable**
- **Efficient**

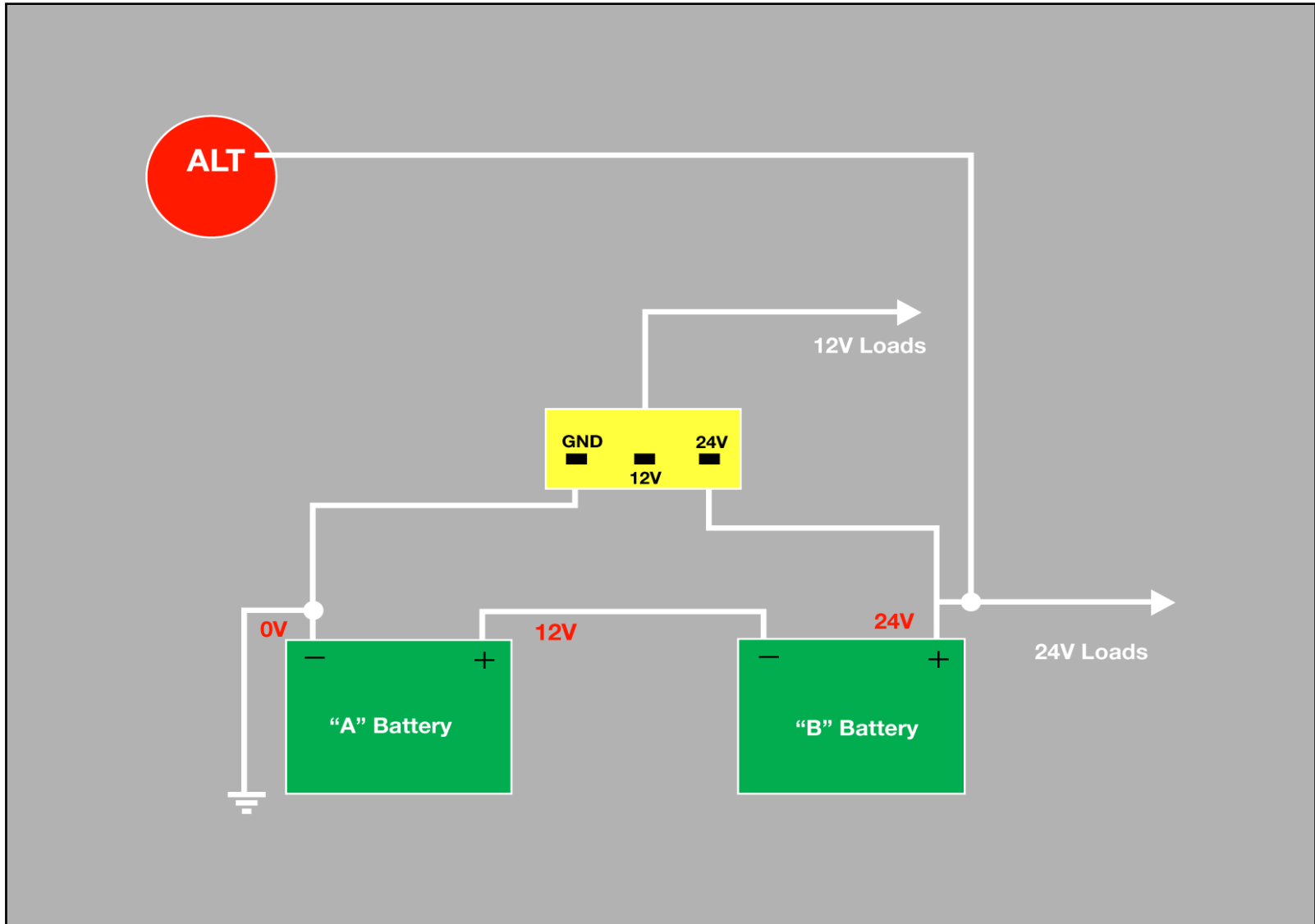
Disadvantages

- **Limited Power Output**
 - 140W to 1100W
most common
- **Not fail safe**
- **Will not support loads with high in-rush current**

- **Commonly used**
 - European Truck and Bus Market
 - North American Construction Equipment Market
 - North American Bus (limited)
- **Output Voltage is fixed**
- **Voltage is stepped down to power 12V loads up to approximately 1400W**



24V-12V Buck DC-DC Converter



Advantages

- **Simple to**
 - Implement
 - Wire
 - Understand
- **Reliable**
- **Efficient**

Disadvantages

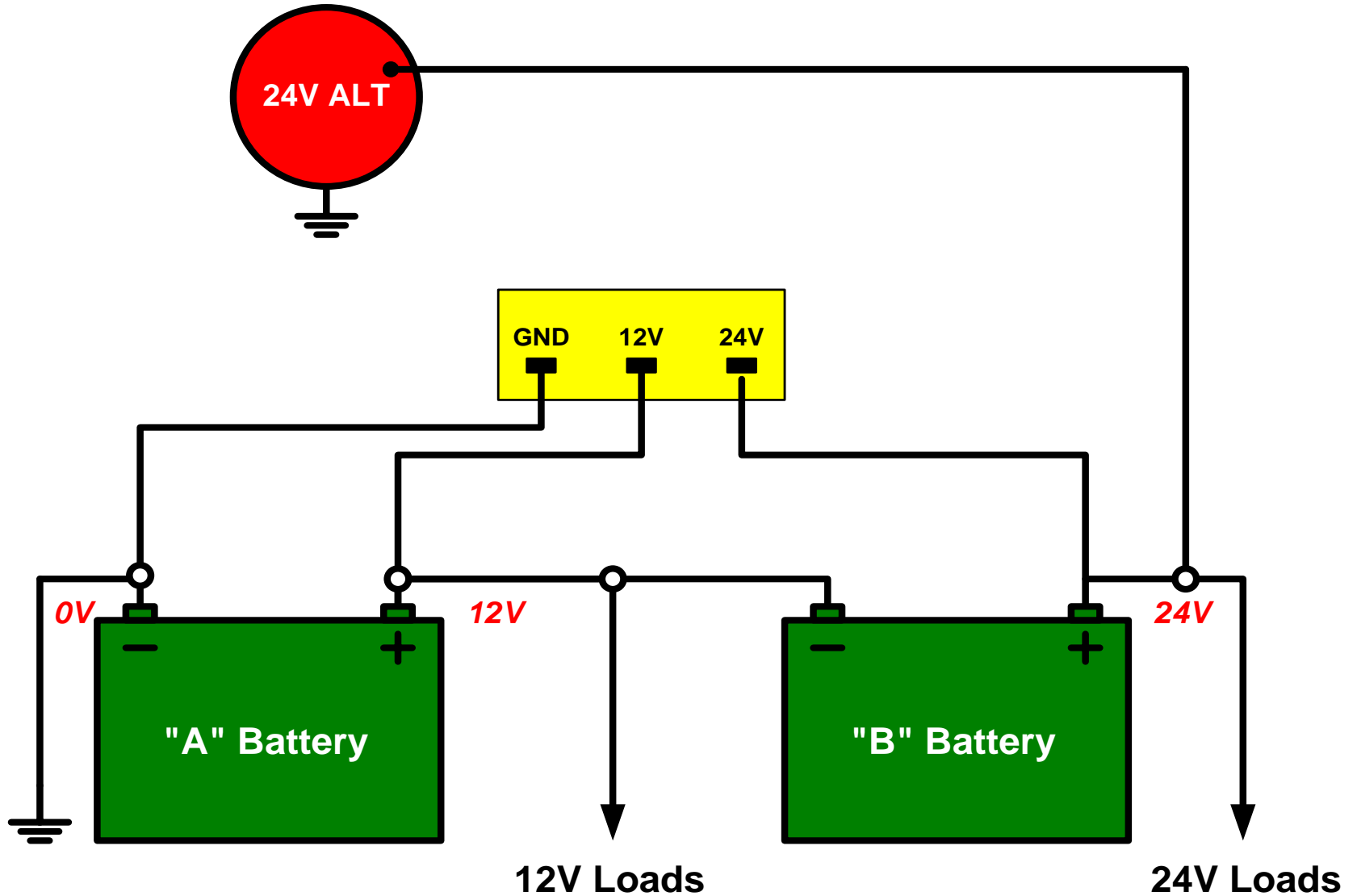
- **Limited Power Output**
 - 40W to 1400W
most common
- **Not fail safe**
- **Must be sized for maximum in-rush current**
- **More expensive**

- **Technically, Equalizers are specialized DC-DC converters. These devices convert electrical power from one voltage level to another at relatively high efficiencies. Used in battery balancing applications, the Converters are called “*Equalizers*”.**
- **The term “*Equalizer*” is derived from the fact that these devices balance or *Equalize* the charge within the system batteries. In the case of 24/12V, dual voltage system, the Equalizer output voltage is equal to half of the input voltage.**

- **Commonly used**
 - North American Bus and Transit
 - Military Applications
 - Off-highway
- **Voltage is stepped down to power 12V loads up to approximately 1400W**
- **Output Voltage is 0.5 X Input Voltage**
- **Battery Bank is CENTER TAPPED**
 - Equalizer maintains battery balance



24V-12V Battery Equalizer



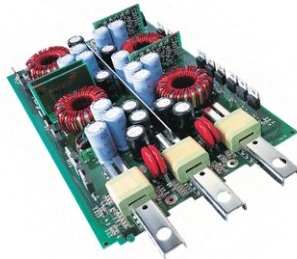
Advantages

- **Simple to**
 - Implement
 - Wire
 - Understand
- **Reliable**
- **Efficient**
- **Fail Safe**
 - Battery backup always available
- **Will support loads with high in-rush current**
- **Batteries always balanced**

Disadvantages

- **Requires additional battery connection**
 - **24V Positive**
 - 12V Positive
 - **System Ground**
- **Requires two battery disconnect switches for complete service disconnect**

- **24V to 12V – Output currents from 2.5A to 100A**
- **12V to 24V – Output currents from 5A to 40A**
- **12V to 36V – 10A**
- **48V to 12V – 20A**
- **72V to 12V – 30a (Input voltage from 54V to 120V)**
- **300V to 12V Converter in development**



Converters compared to Equalizers

Converter Features	Equalizer Features
Fixed output voltage independent of input voltage.	Output voltage is ½ of input voltage.
Only two connections to battery (+24V and GND).	Three connections to battery (+24V, +12V, and GND).
Battery issues may still result in equalization problems.	Ensures that batteries are always have balanced voltage.
The input voltage (24V) can be applied to the output if the converter fails.	The 12V battery prevents over-voltage, and will take over loads in case of equalizer failure.
Output voltage (12V) may dip under transient loads (motor starting, incandescent bulbs, etc.)	The 12V battery will absorb transient loads or loads with high inrush current.
Converter can be mounted most anywhere (e.g. near the loads).	Equalizer must be mounted near the batteries.
Multiple converters can be used to drive separate loads.	Parallel operation of equalizers is not recommended.

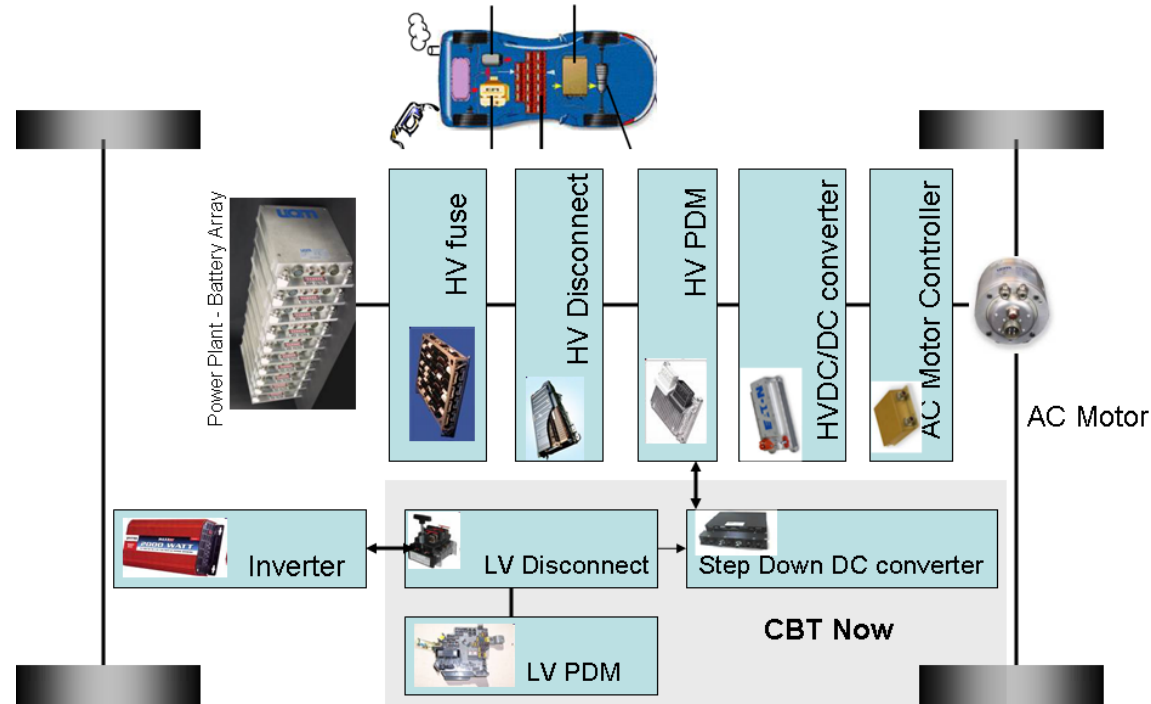
Summary

There is no clear best choice between a converter and an equalizer. Much of the decision should be based on the nature of the loads connected to the equalizer/converter. In the case of an engine ECU it may be more important that the vehicle still operate in the event of a converter/equalizer failure. If the loads are various accessory bulbs or a radio it may be more important that the output voltage be fixed, and the converter mounted apart from the batteries. However, in general, the equalizer advantages tend to be more important than those of a converter.

- **Continue elimination of Potting**
- **DC to AC Inverters**
- **High Voltage DC Converters for Hybrid Vehicles (320V / 600V to 12V)**
- **Converters with High Voltage outputs for electrification of belt driven loads (12V to 320V)**

Summary

- Highest technology growth in Power Conversion (>20% annually)
- Driven by high fuel prices and demand for reduced emissions
- Beginnings of completely new markets



Trends

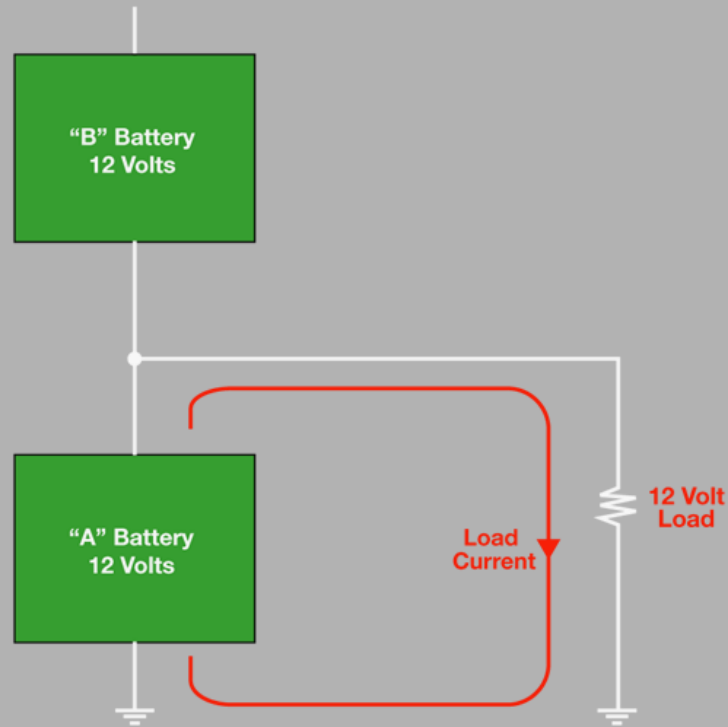
- High Voltage DC Power (>600V)
 - Fuse box
 - HV disconnect
 - Power Distribution
- AC Motor Controllers needed for all EVs
- AC Power demand increasing (in-vehicle cabin)

CBT Strategy

- Internal product development where appropriate leverage exists
- Acquire technology to fill gaps (actively looking w/ targets identified)

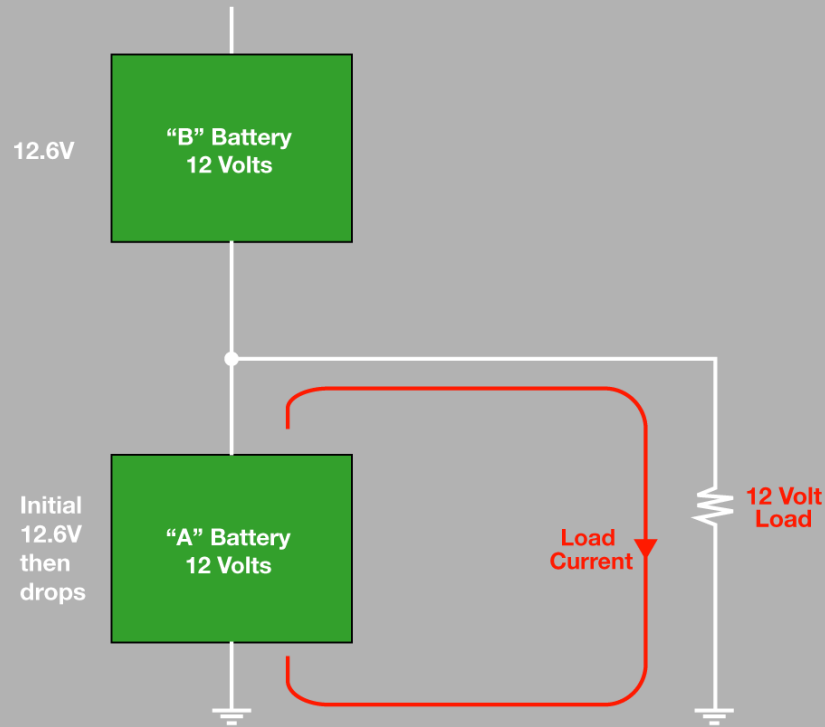
EV and Hybrid Systems require multiple Power and Control Technologies

WHY IS AN EQUALIZER NECESSARY? (Engine Off)



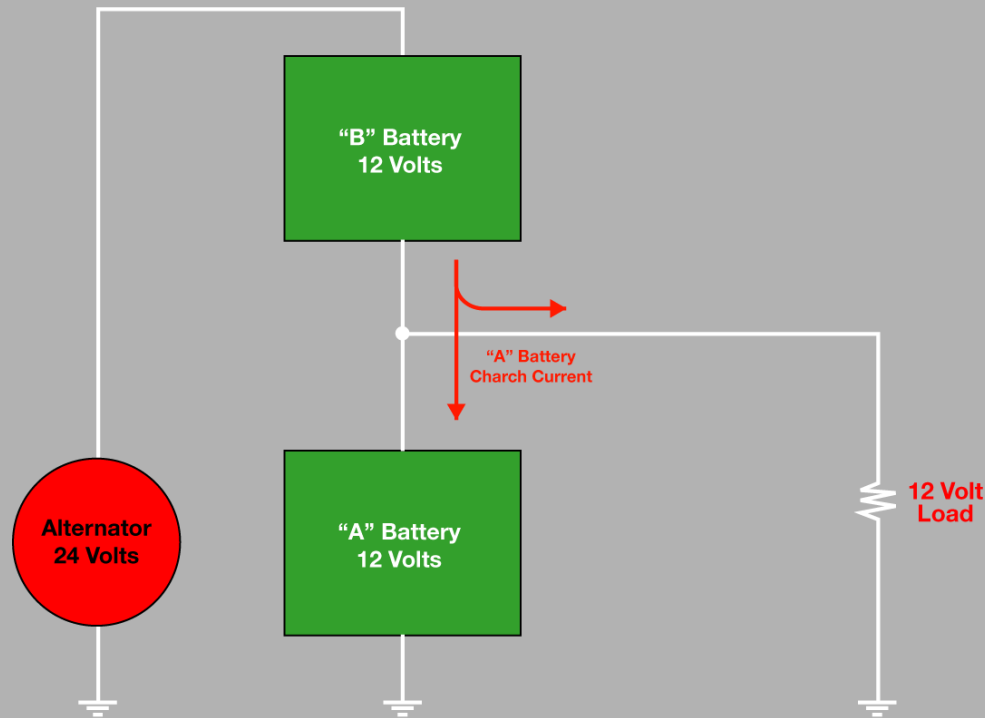
The "A" battery becomes discharged by the 12 volt load while the "B" Battery remains charged. Results in a battery charge imbalance.

WHY IS AN EQUALIZER NECESSARY? (Engine Off)



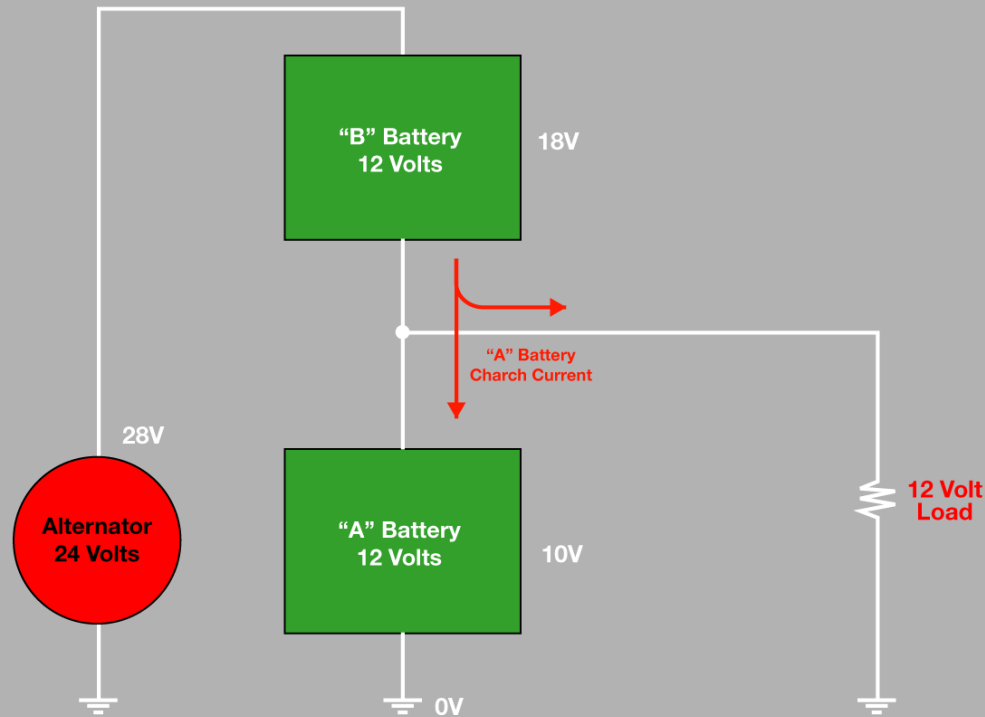
The "A" battery becomes discharged by the 12 volt load while the "B" Battery remains charged. Results in a battery charge imbalance.

Why is an equalizer necessary?
(Engine On)

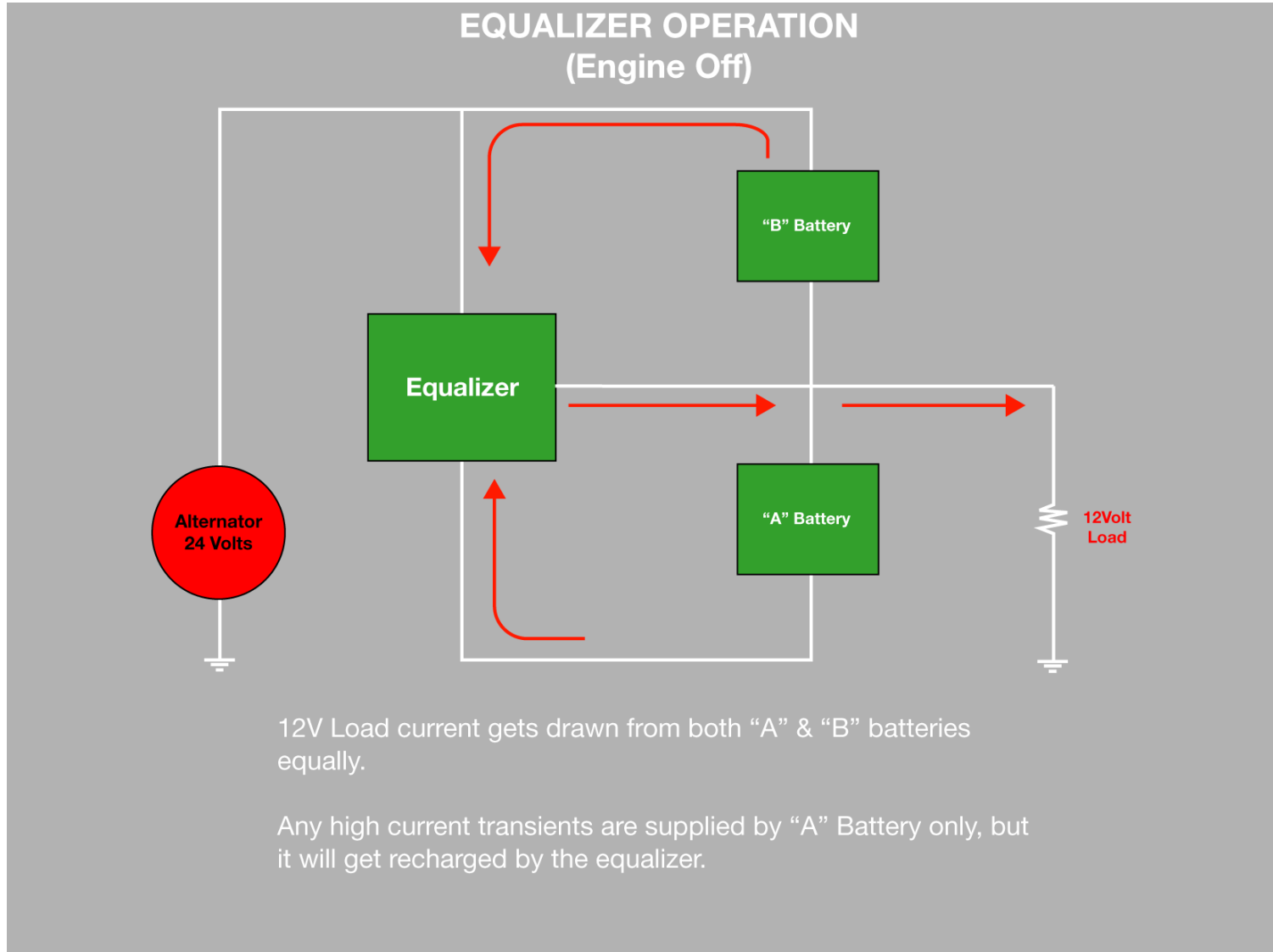


The "B" Battery becomes overcharged. Eventually alternator may not be able to supply any current to 12 volt load due to "B" battery overcharge. "A" battery will then have excessive discharge.

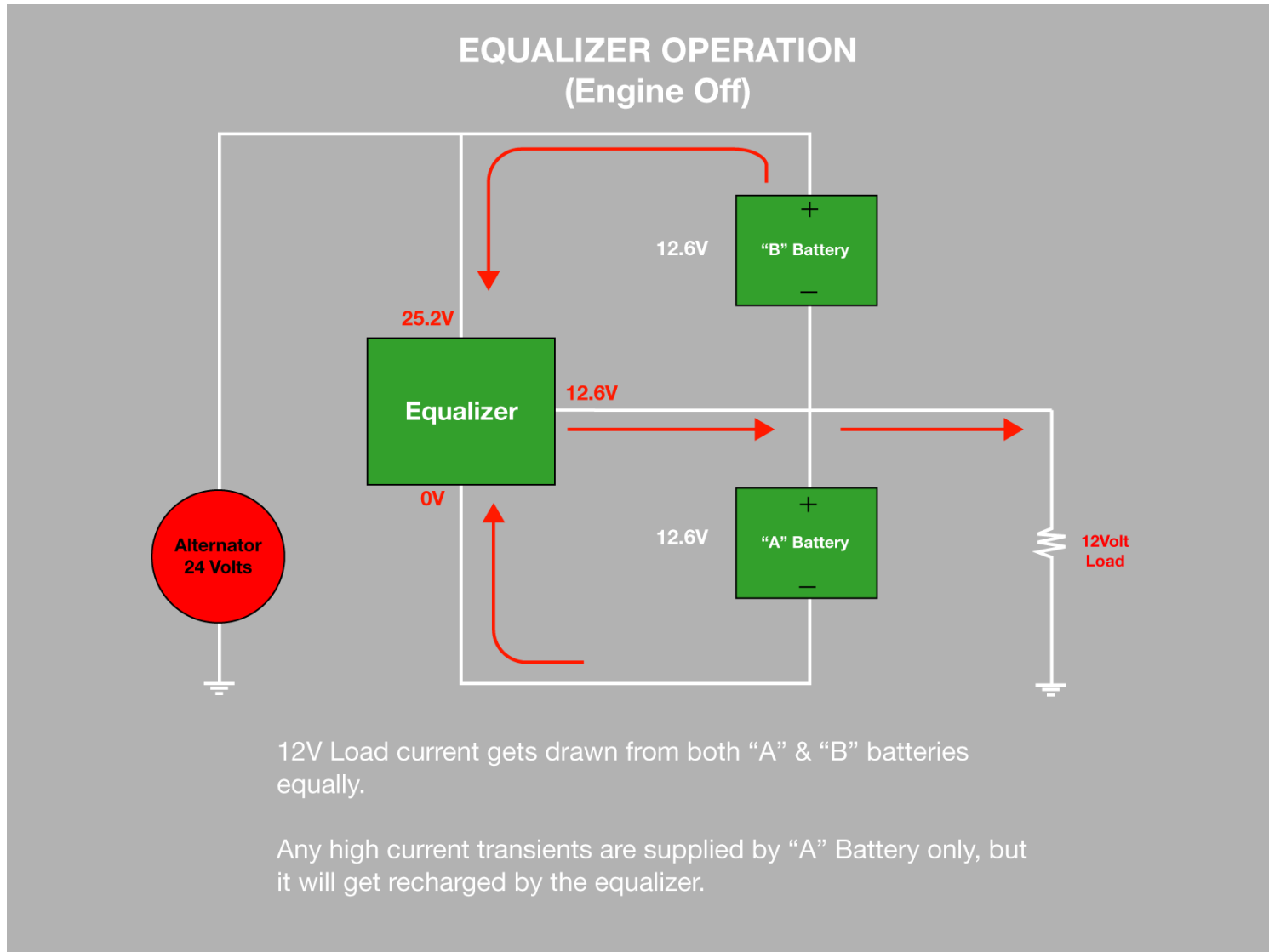
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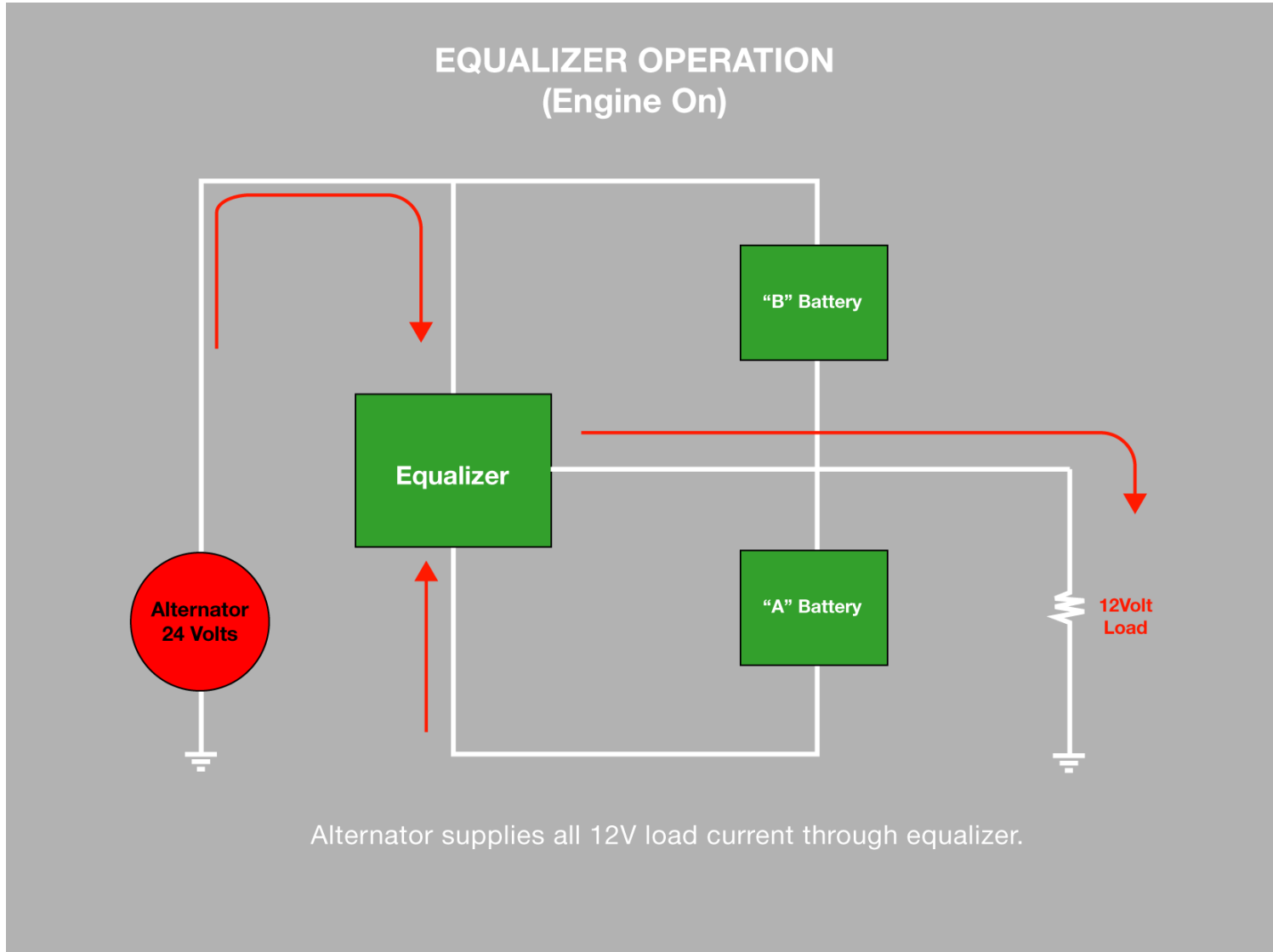


The "B" Battery becomes overcharged. Eventually alternator may not be able to supply any current to 12 volt load due to "B" battery overcharge. "A" battery will then have excessive discharge.



Battery Equalizer - Engine Off Operation





Battery Equalizer - Engine On Operation

