

BONUS
CONTENT



**BATTERY TECHNOLOGY
CHALLENGES AND
OPPORTUNITIES FOR
ELECTRIFICATION DEVELOPMENT**

EQUIPMENT MARKET OUTLOOK ON-THE-GO

JUNE 2019



Although 2019 is outperforming 2018 numbers when compared year over year, growth rates and indicators are seeing declines around the world and across industries. For example, U.S. Construction Machinery New Orders are in a slowing growth trend, further signaled by the U.S. ISM Purchasing Managers Index.

Similarly, Europe's Industrial Production is virtually flat compared to last year while the production average continues to decline, but the Europe Leading Indicator and Eurozone Purchasing Managers Index formed tentative cyclical troughs, indicating possible recovery.

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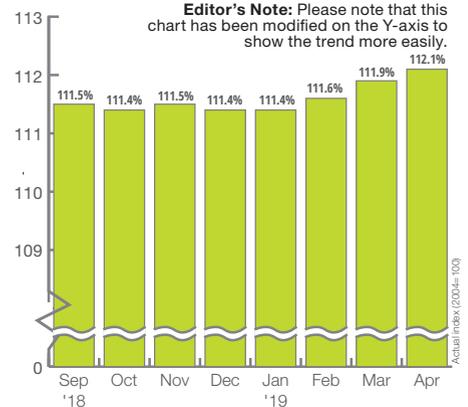


ITR Economics is an independent economic research and consulting firm with 60+ years of experience.



U.S. Leading Indicator:

- The Conference Board's US Leading Indicator moved higher in April. The pace of growth is declining.
- Decline in the Indicator monthly rate-of-change suggests that US Industrial Production is likely to be in business cycle decline (slowing growth or recession) through at least the end of the year.



U.S. Industrial Production:

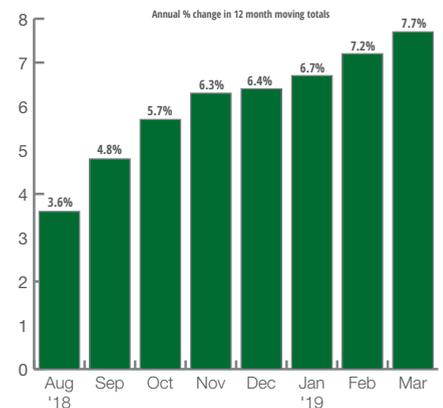


- Quarterly average U.S. Industrial Production moved lower in recent months but was 2.0% above the year-ago level in April.
- Further decline in the Production quarterly rate-of-change is probable in at least the near term, given the trends in the OECD's U.S. Leading Indicator.



U.S. Total Public New Construction:

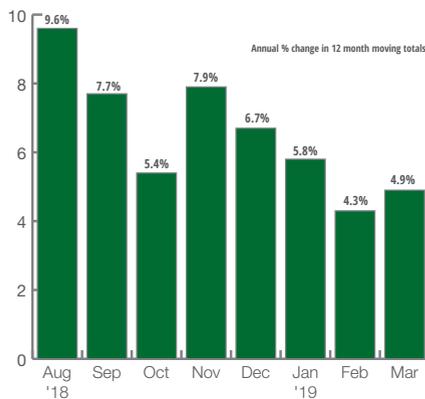
- U.S. Total Public New Construction during the 12 months through March totaled \$306.7 billion, 7.7% higher than last year. Construction is in an accelerating growth trend.
- Construction is rising at the fastest pace in over a decade. Prior trends in U.S. Federal Government Current Tax Receipts suggest the Construction annual growth rate could peak in the near term.





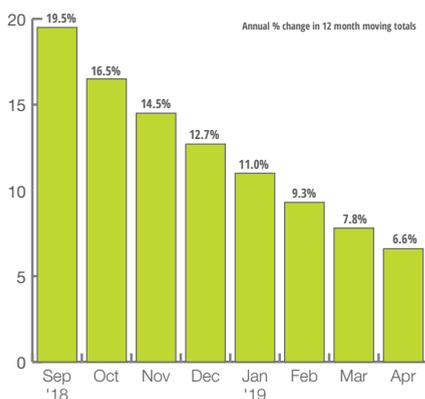
U.S. Construction Machinery, New Orders:

- U.S. Construction Machinery New Orders during the 12 months through March totaled \$35.9 billion, up 4.9% from one year ago. New Orders are in a slowing growth trend.
- Further slowing growth and potential contraction in New Orders in at least the coming quarters is suggested by trends in the U.S. ISM PMI (Purchasing Managers Index).

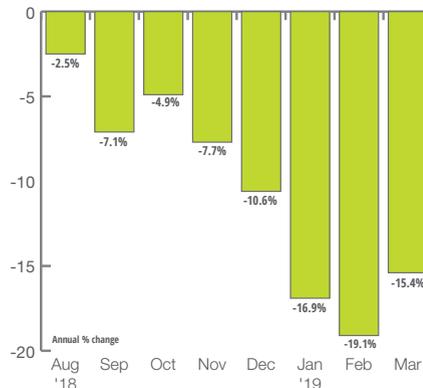


North American Rotary Rig Count:

- The North American Rotary Rig Count annual average has moved lower over the last three months, coming in at 1,238 rigs in April. Despite recent decline, the annual Rig Count is 6.6% higher than one year ago.
- Trends in the U.S. Wilshire Total Market Capitalization Index suggest further business cycle decline in the Rig Count into at least late in the year.



China Diesel Bus Production:

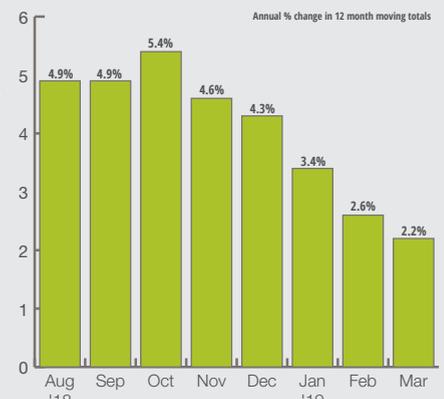


- Annual China Large Diesel Bus Production ticked up in March to 28.8 thousand units. The pace of contraction eased slightly; annual Production is down 15.4% from one year ago.
- Trends in the China Leading Indicator suggest that year-over-year decline in Production could become less severe in the second half of 2019.

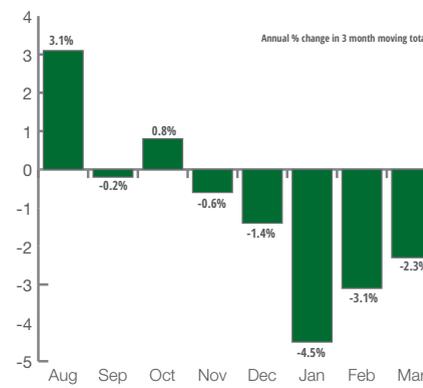


U.S. Private Nonresidential New Construction:

- Q1 U.S. Private Nonresidential New Construction totaled \$106.4 billion, 2.2% higher than one year ago. The pace of growth is diminishing, but trends in the US Commercial and Industrial Sector Architecture Billings Index suggest that the growth rate could rise in the near term.
- The Multi-Tenant Retail Construction segment was down 29.4% in the first quarter relative to the same quarter last year and is dragging down the performance of the whole.



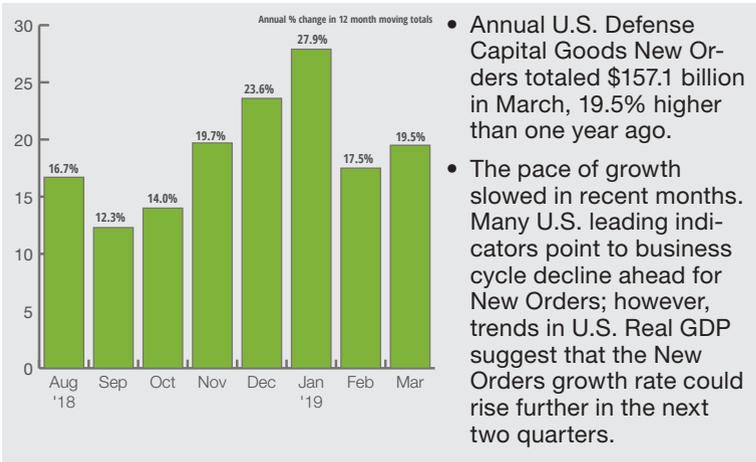
Germany Industrial Production:



- Quarterly average Germany Industrial Production ticked up slightly in March, coming in 2.3% lower than one year ago.
- The Europe Leading Indicator and Eurozone PMI formed tentative cyclical troughs, indicating that recovery in Production may materialize in the near future. However, Germany's heavily export-reliant economy is susceptible to adverse effects stemming from the global trade war and Brexit. Tread carefully in Germany, and in Western Europe more generally, this year.



U.S. Defense Industry, New Orders:



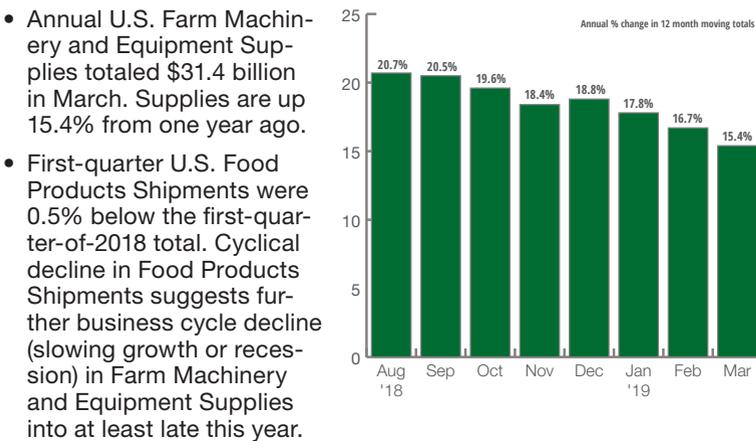
Editor's Note:
Please note that this chart has been modified on the Y-axis to show the trend more easily.

Europe Leading Indicator:

- The Europe Leading Indicator declined in March. However, the pace of contraction eased for the second month in a row.
- The tentative January low in the Indicator rate-of-change suggests that Europe Industrial Production could enter a recovery trend during the fourth quarter of the year, given the typical 10-month lead time from changes in the Indicator to changes in Production.



U.S. Farm Machinery Production:

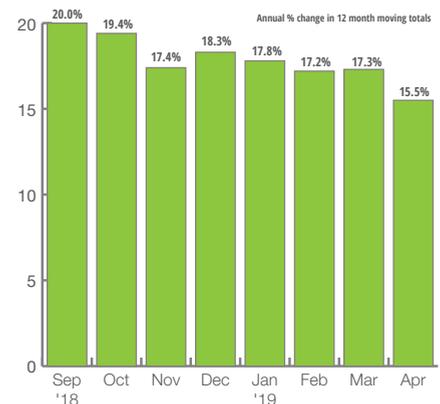
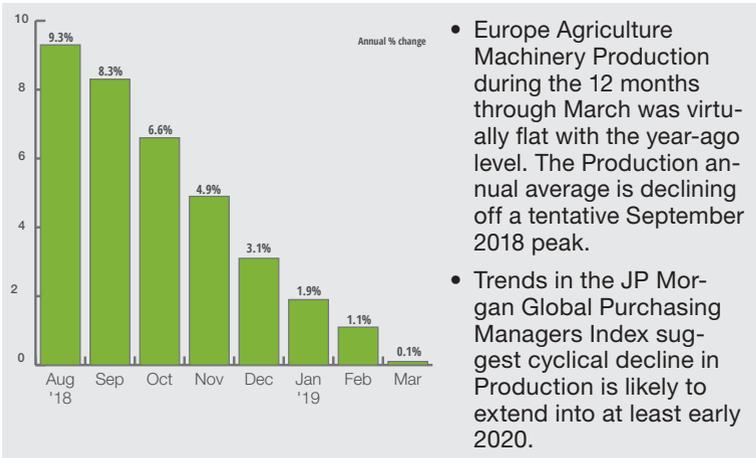


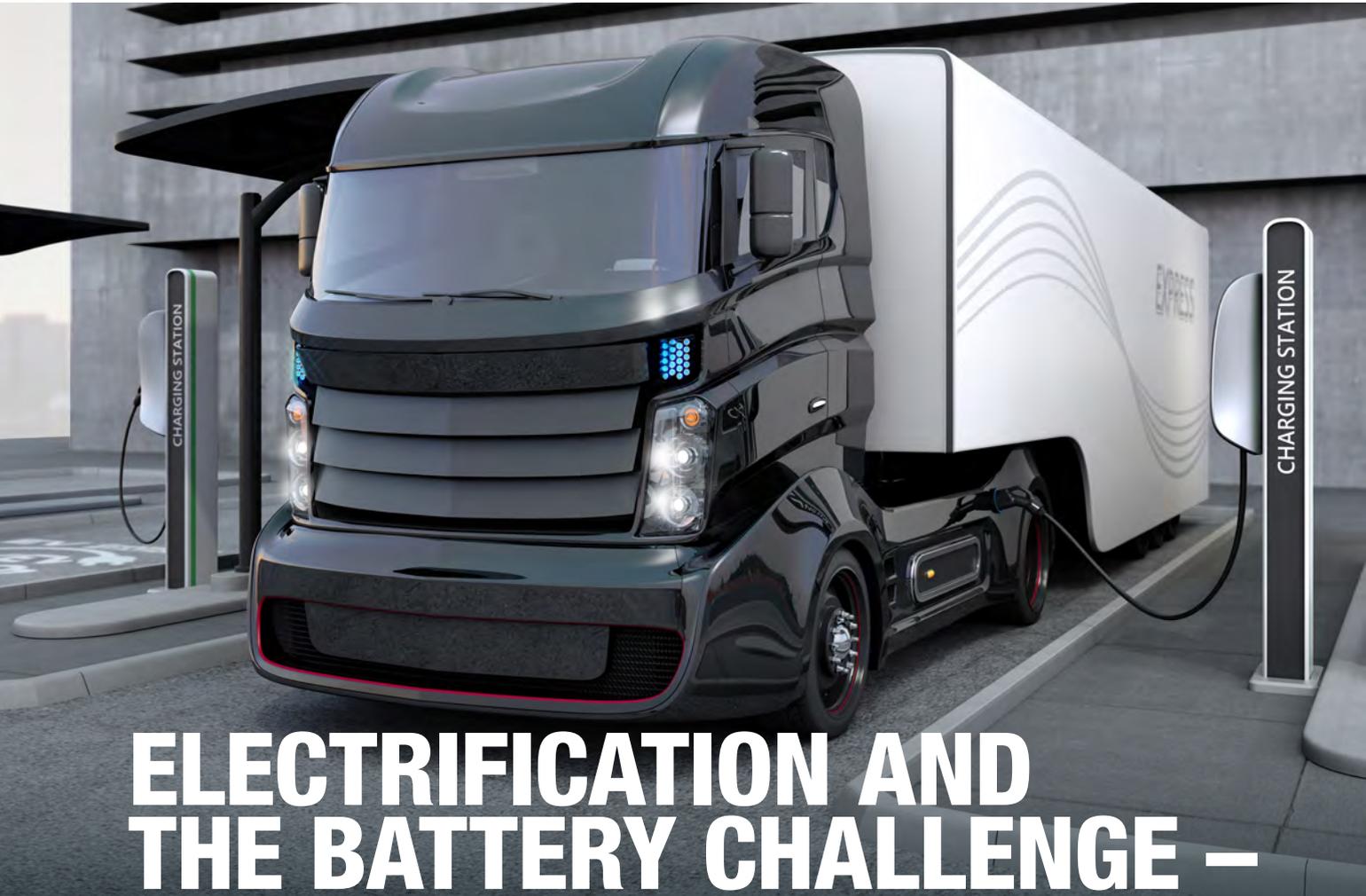
U.S. Heavy-Duty Truck Shipments:

- Annual average U.S. Heavy-Duty Truck Production in April was 15.5% higher than one year ago. Trends in quarterly Production suggest further business cycle decline on the horizon.
- Business-to-business activity, as measured by US Nondefense Capital Goods New Orders (excluding aircraft), is expected to move lower during the second half of the year. This could limit demand for new heavy-duty trucks during the same time period.



Europe Ag & Forestry Machinery Production:





ELECTRIFICATION AND THE BATTERY CHALLENGE – AND OPPORTUNITY

TAKING A CLOSER LOOK AT WHERE BATTERY TECHNOLOGY STANDS CURRENTLY, AND WHERE IT LENDS ITSELF FOR FUTURE PROGRESS AND DEVELOPMENT.

by Michelle Kopier

It is no secret that as electrification has become an accepted end-goal, the main hurdle standing in the way of larger success and implementation is battery technology. Between the sheer size and weight of the system, it can prove challenging to integrate the amount of power a heavy-duty vehicle needs to offset its diesel engine power system.

The Advanced Clean Transportation (ACT) Expo focuses on alternative powered vehicles utilizing power sources ranging from propane to natural gas to hydrogen to batteries. According to Andrew Halonen, a contributor to OEM Off-Highway magazine and industry consultant, “Of all the available vehicle propulsion technologies at this year’s ACT Expo, electrification absolutely stole the show. Most of the keynote speakers were focused on

➤ Beyond battery technology advancements, the electrified vehicle market needs a more established and widespread charging infrastructure to support the growing vehicle unit count.

commercial battery electric vehicles (CBEV).” *Read Halonen’s full report, “Observations from ACT Expo 2019,” at OEMOffHighway.com/21070710.*

In a workshop run by the North American Council on Freight Efficiency, medium-duty trucks were seen as a market in which battery electric vehicles made sense. Medium-duty trucks are not sensitive to weight; have lower mileage per day, averaging 50-100 miles per day; and are regional in their route patterns and return back to a home-base each night so as not to necessitate a developed charging network.

However, when it comes to heavy-duty vehicle applications, batteries are still lacking in an economical cost structure and a power density demands. That’s not to say that larger OEMs aren’t unveiling battery-powered vehicles. Volvo Construction Equipment, for example, has a range of electric compact wheel loaders and excavators, and is starting to enter into this stage with its larger vehicle models.

CHALLENGES YET TO BE OVERCOME

Size, weight, power density and cost – these are the challenges facing current batteries. According to the joint survey conducted by *OEM Off-Highway* and Waytek, 32% of the industry professionals surveyed considered battery technology the primary challenge against electrification, followed by the cost of implementation at 28% and the industry’s resistance to change at 22%.



To read more on the survey results, go to Waytek’s [Just the Facts: A Quick Read on Electrification in Heavy-Duty Equipment](#).

According to the survey respondent, in order for electric systems to be considered an attainable goal for the heavy-duty vehicle market, advancements in electrification development need to focus on rapid recharging capabilities to minimize downtime, longer continuous operation through higher power density, and reducing overall battery size.



Several OEMs and corporations are investing and investigating in battery technology advancements to meet the challenge head on. Maxwell Technologies Inc., a developer and manufacturer of energy solutions announced earlier this year that it would be [acquired by Tesla Inc.](#) Maxwell had recently been discussing dry electrode technology for batteries which is speculated to be the technology in which Tesla is most interested.

Daimler announced it had [acquired a minority equity stake in Sila Nanotechnologies Inc.](#), a U.S. battery material specialist, to help accelerate the development and commercialization of lithium-ion battery technologies for electric vehicles.

“We are on our way to a carbon free future mobility,” says Sajjad Khan, Executive Vice President for Connected, Autonomous, Shared & Electric Mobility, Daimler AG. “While our all-new EQC model enters the markets this year we are already preparing the way for the next generation of powerful battery electric vehicles. Lithium-ion technology is currently the most efficient battery technology available, and still shows plenty of potential for the future. The advancements Sila Nano have made in battery performance are very promising. We are looking forward to a fruitful cooperation, pooling our know-how on further development and fast commercialization.”

AxleTech announced it had entered into a [strategic agreement with Agility Fuel Solutions](#) to harness the company’s clean fuel solutions in order to provide the industry with a complete and fully integrated electric powertrain solution for commercial vehicles. In April, Agility introduced its [high-performance battery packs](#) and complete electric vehicle drivetrain integrations for medium- and heavy-duty trucks at ACT Expo. The lightweight, liquid-cooled lithium-ion battery packs are configurable in 110 kWh increments, up to 440 kWh for Class 8 truck applications, and exceed 150 Wh/kg.

And just recently at the end of May, American Battery Solutions, Inc. announced it had signed an [agreement to acquire manufacturing and testing assets](#) for high-voltage battery systems from Robert Bosch Battery Systems. According to the [announcement](#),

ABS will supply modular battery solutions to underserved transportation, industrial and commercial markets, primarily in North America and Europe. It will partner with the world's leading OEMs, system integrators and battery manufacturers to supplement and extend their brands with a combination of engineering, testing and manufacturing services. The venture will partner with leading cell manufacturers, to offer a variety of chemistries and cell form factors to optimize each application.

Target applications will include:

- *High performance and autonomous EVs;*
- *Delivery trucks, buses and utility vehicles;*
- *Rail and marine;*
- *Mobile commercial power;*
- *Material handling equipment; and*
- *Construction, agriculture and mining equipment.*

While at ACT Expo, Halonen points out the number of solutions that house the battery packs outside of the vehicle frame. In a conversation with an engineer who had done considerable testing on EV batteries under impact, the engineer was “astonished” to see so many battery

boxes outside the protection of the frame rails. Halonen clarifies: “In heavy-duty trucking, there is still a need for a robust battery structure, yet there is a predicament—the required volume of batteries is much larger than the space available between the frame rails. The current frame configuration was designed for the IC engine, transmission and driveline.”

In an [industry analysis](#) provided by market research firm IDTechEx, several examples of heavy-duty vehicles modified with batteries were noted. One such example



involved two Swiss companies that disassembled a Komatsu 605-7 to replace the diesel engine with a 590 kW (800 hp) synchronous electric motor and a 700 kWh lithium-ion battery using 1,440 prismatic lithium-nickel-manganese-cobalt-oxide (LiNiMnCo, or NMC) lithium-ion cells; the total battery pack system weighs 4.5 tons.

In order to reduce these massive battery weights, the battery chemistries need to improve, or, notes Halonen, “the battery charging technology [needs to improve] to be able to charge significantly faster [so] trucks may require fewer batteries.”

On top of technology and packaging challenges, battery-powered vehicle commercialization also lacks a key element – infrastructure. Especially in rural areas, [a] reliable charging system is essential for electrification to achieve widespread growth.

According to one survey responder, “It’s not about whether or not electrification can compete from a performance perspective, because it most certainly can. The trick is going to be both storing such volumes of energy efficiently within the confines of the vehicle and replenishing these energy reserves (refueling) by readily available means.”

Read the full report, [“The State of Electrification in Off-Road and Heavy-Duty Equipment,”](#) based on the results of the survey conducted by Waytek in collaboration with *OEM Off-Highway*.

i More battery-powered vehicle information:

[Electric Powertrain Design Takes Teamwork](#)

[Tesla Unveils Electric Semi Truck](#)

Need more resources for electrification trends? Head to [OEMOffHighway.com/trends/electrification](https://www.oemoffhighway.com/trends/electrification) for all of the latest relevant industry news and product announcements in the electrification market.

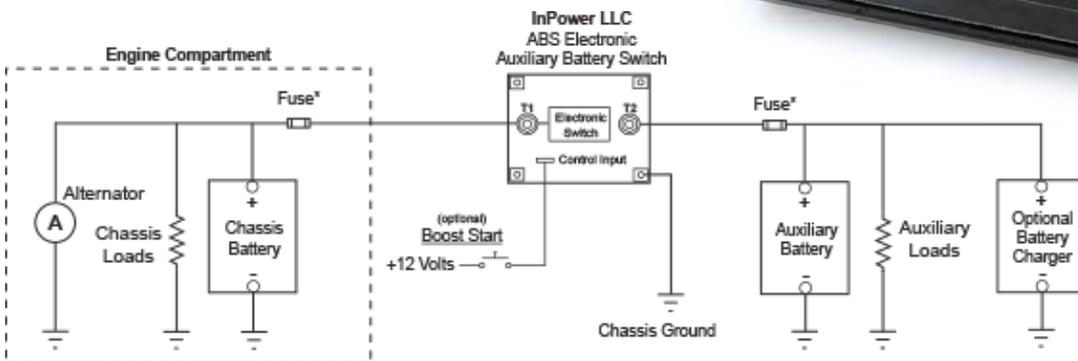
ELECTRONIC AUXILIARY BATTERY SWITCHES

Solid State Technology that Doesn't Quit!

As the automotive world moves toward electrification, battery technology must follow in order to keep up with new demands. InPower's Auxiliary Battery Switches (ABS) meet these expectations and continue to evolve. With a 100% electronic, solid state design, the ABS are built for charging auxiliary batteries while isolating them from the vehicle chassis battery and alternator.

- Higher operational life than diode based battery isolators and mechanical solenoids
- Current ratings from 100-200 amps
- Prevents issues related to over-current, over-temperature and under voltage
- Efficient operation, no massive heat sinks required
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How It Works:



* Fuse should be 25 amps higher than ABS amperage.



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