

ALL ABOUT BATTERIES

&

Chargers and Converters

Elliot Actor

Feb 20, 2022

Primary Technical Sources

- Interstate Batteries - Lead Acid Batteries, AGM Batteries, Chargers
- Battery Tender – Smart Battery Chargers
- Optimate (TecMate) – Desulfation Chargers
- Dakota Batteries – Lithium Batteries, Lithium Charging
- Battle Born Batteries - Lithium Batteries, Heated Lithium Batteries, and BMS
(Battery Management System)
- Offroad Living – Charging Lithium Batteries
- Enerdrive (Dometic) – Charging Lithium Batteries
- Parallax – Battery Chargers and Airstream Converter History
- Progressive Dynamics – Converter Upgrades, Desulfation
- WFCO – Converter Upgrades
- Amazon – Lithium Battery Prices and Converter Upgrades (Cheapest Source)
- Air Forums - Battery Upgrades, Converter Problems
- Pat McDowell #10777– Airstream Electrical History

Battery Types

LEAD ACID (“Flooded Lead Acid”)

A Lead Acid Battery consists of plates of Lead Oxide, the positive plate, and Lead, the negative plate, separated by a permeable membrane immersed in an electrolyte of water and sulfuric acid and incased in a hard plastic case.

Starting

Higher cranking amps – Quick burst of energy

Sealed versions available – No maintenance over normal life expectancy

Inexpensive

Deep Discharge

Greater long-term delivery – Deeper discharge

More rugged internal construction

Inexpensive

Battery Types

AGM (Absorbed Glass Mat)

The chemistry of an AGM batteries is the same as a Lead Acid battery except the Lead and Lead Oxide plates are separated by an absorbent glass mat that absorbs and holds the battery's acid and prevents it from flowing freely inside the battery. The plates are tightly compressed into each cell and held under pressure in the plastic case.

No outgassing

Maintenance free

Mount in any position

More useable capacity (80% vs 50% for Lead Acid)

Typically have longer life

Charge faster (less internal resistance)??

50 % More expensive than Lead Acid

Overcharging an AGM battery can cause permanent damage and older battery chargers may not be suitable to use

Battery Types

LITHIUM - LiFeP04 (Lithium Iron Phosphate or LFP)

Comprised of 3.6 Volt 18650 cells in a series/parallel combination

Can use full capacity vs 50-80% for Lead Acid or AGM

Much lighter

Can mount in any position

Last much longer

Charge much faster

Much more expensive 4-10X

Cannot charge below freezing unless heated

What Kind of Batteries Does Tesla Use?

- Tesla currently uses mainly NCA chemistry (Lithium-Nickel-Cobalt-Aluminum), while NMC (Lithium-Manganese-Cobalt) is more common in the rest of the EV industry.
- In China the Model 3 and Model Y now use LFP (Lithium Iron Phosphate), which is cheaper, safer, but less power dense. Tesla switching to LFP for those models worldwide to reduce costs.
- Tesla's new 4680 battery cell (Coming 2023) is more power dense, cheaper to manufacture, and **Cobalt free**. It uses Nickel in place of Cobalt for its cathode.

Most Cobalt comes from The Democratic Republic of Congo and is mined by child or forced labor.

Future Batteries?

DEVELOPMENT GOALS

Safer (Prevent fires)

Better and cheaper packaging

Eliminate rare elements (Like Cobalt)

Reduce costs

Higher energy density

Faster charging

Longer life

TECHNOLOGIES CURRENTLY IN DEVELOPMENT

Lithium Sulfur

Lithium Tungsten

Lithium Air

Graphite Aluminum Ion

Aluminum Ion

Aluminum Air

Zinc Manganese Oxide

Organosilicon

Battery Measurements

COLD CRANKING AMPS (**CA**)

Not important with Deep Cycle

RESERVE CAPACITY (**RC**)

Minutes a battery can discharge 25 Amps

AMP HOUR (**AH**) = Energy storage capacity of battery

$$**AH** = 0.4167 \times **RC**$$

Operating Temperature Range

LEAD ACID & AGM

- Lead Acid and AGM Batteries have an operating range of -40 degrees F to 140 degrees F.
- Cold weather is not harmful to a Lead Acid or AGM battery as many of us were taught. As long as the battery(s) are kept charged you do not need to remove them when storing your trailer.
- Cold weather does affect the performance as at 32 degrees F (freezing) the capacity is reduced by 20% and at 0 degrees F it is reduced to 50%. Also, while a completely discharged battery can freeze at 20 degrees F, **a fully charged battery will not freeze until -70 degrees F.**

LITHIUM (LiFeP04)

- LiFeP04 batteries have an operating range of -14 degrees F to 140 degrees F (Constrained by Battery Management System)
- They will operate in that range without significant performance degradation, however, **they cannot be charged below 32 degrees F.**

Battery Life Expectancy

LEAD ACID (Without Desulfation)

Real Life*

Life expectancy typically, 3-5 Years

30% Reach 48 Months

5% Reach 60 Months

Tested Discharge Cycle Life *

220 Cycles at 80% DOD (Depth of Discharge)

750 Cycles at 50% DOD

2000 Cycles at 25% DOD

>80% DOD Can Damage Battery

*Based on Interstate Battery data - Due to Sulfation, too deeply discharged, or low electrolyte level and cannot be re-charged above 70% capacity or 12.3 Volts

Battery Life Expectancy

AGM - Absorbed Glass Mat (Without Desulfation)

Real Life*

Life Expectancy typically 5-7 Years

Tested Discharge Cycle Life*

600 Cycles at 80% DOD

1000 Cycles at 50% DOD

2500 Cycles at 25% DOD

>90% DOD Can Permanently Damage Battery

*Based on Interstate battery data - Due to Sulfation or too deeply discharged and cannot be re-charged above 70% capacity or 12.3 Volts

Sulfation

- The primary reason for the failure of Lead Acid and AGM batteries is due to sulfation, the buildup of lead sulfate crystals on the plates of the battery that make it increasingly ineffective.
- Sulfation occurs due to inappropriate charging and discharging, which is common in batteries that are routinely deeply discharged.
- There are many different proprietary methods that charger manufacturers use to dislodge the sulfate crystals from the battery's plates and mix them back into the electrolyte, rejuvenating the battery or even **reviving a dead battery**.
- Each manufacturer is convinced their methodology is the best.
- However, all the methods consist of connecting the battery periodically or on demand with a steady or oscillating on-and-off higher voltage pulse from several seconds to several minutes in duration.
- This process is called Desulfation or, less frequently, Equalization Stage.
- What they all agree on is that Desulfation can significantly **increase battery life by 2-3X**.
- Many batteries in testing are still operational (>70% efficient) after **12 or more years**.

Battery Life Expectancy

LITHIUM (LiFeP04)

2500 Cycles at 80% DOD

3000 Cycles at 70% DOD

5000 Cycles at 50% DOD

12000+ Cycles at 25% DOD

3000 Cycles at 100% DOD (Battle Born)

Can Be Discharged to 100% DOD Without Permanent Damage

Lithium Battery Management Systems (BMS)

- The primary function of the BMS is to protect the battery cells from damage caused by temperature extremes or being overcharged or over-discharged.
- Additionally, the BMS also balances the charge across the cells to keep each cell functioning at maximum capacity.
- If the BMS detects any unsafe conditions, it shuts the battery down to protect the lithium-ion cells and the user.
- Most will automatically restart when unsafe condition are over. Some require an external reset.

Battery management systems are critical in protecting the battery's health and longevity but even more important from a safety perspective. The liquid electrolyte in lithium-ion batteries is highly flammable.

Heated Vs Non-Heated Lithium Batteries

Charging a LiFePO4 battery below freezing can damage the battery so the BMS (Battery Management System) of a non-heated battery will not allow charging below that temperature.

- The heater circuit in heated Lithium batteries, when connected, typically kick in at 35 degrees Fahrenheit and turn off at 45 degrees Fahrenheit.
- They draw 1.8 Amps (Battle Born) and at zero degrees Fahrenheit will operate 30% of the time and the battery will last approximately 185 hours before being shut down by the BMS low voltage cutoff.
- A switch is required for each group of Lithium batteries to disconnect heater circuit(s) when storing to not run-down battery.

Battery Dimensions

<u>Size</u>	<u>Length"</u>	<u>Width"</u>	<u>Height"</u>	<u>Wgt#</u>	<u>Wgt#</u>	<u>Typ AH</u>	<u>Typ AH</u>
Group				LA & AGM	Lithium	LA & AGM	Lithium
24	10 1/4	6 7/8	8 7/8	43-57	20-24	55	75
27	12 1/16	6 7/8	8 7/8	54-70	25-30	67	100
31	13	6 7/8	9 3/8	60-75	25-32	87	100
GC2	10 3/8	7 3/16	9 3/8	58-68	22	220 (6V)	100

Increasing Battery Capacity

1) Add Internal Battery(s) in Parallel

AGM or Lithium

2) Replace Existing Batteries w/ Lithium or Larger Size

Group 24 L/A or AGM to Group 24 Lithium

300% Increase

Group 24 to 27

25% Increase L/A or AGM – 400% Lithium

Group 24 to 31

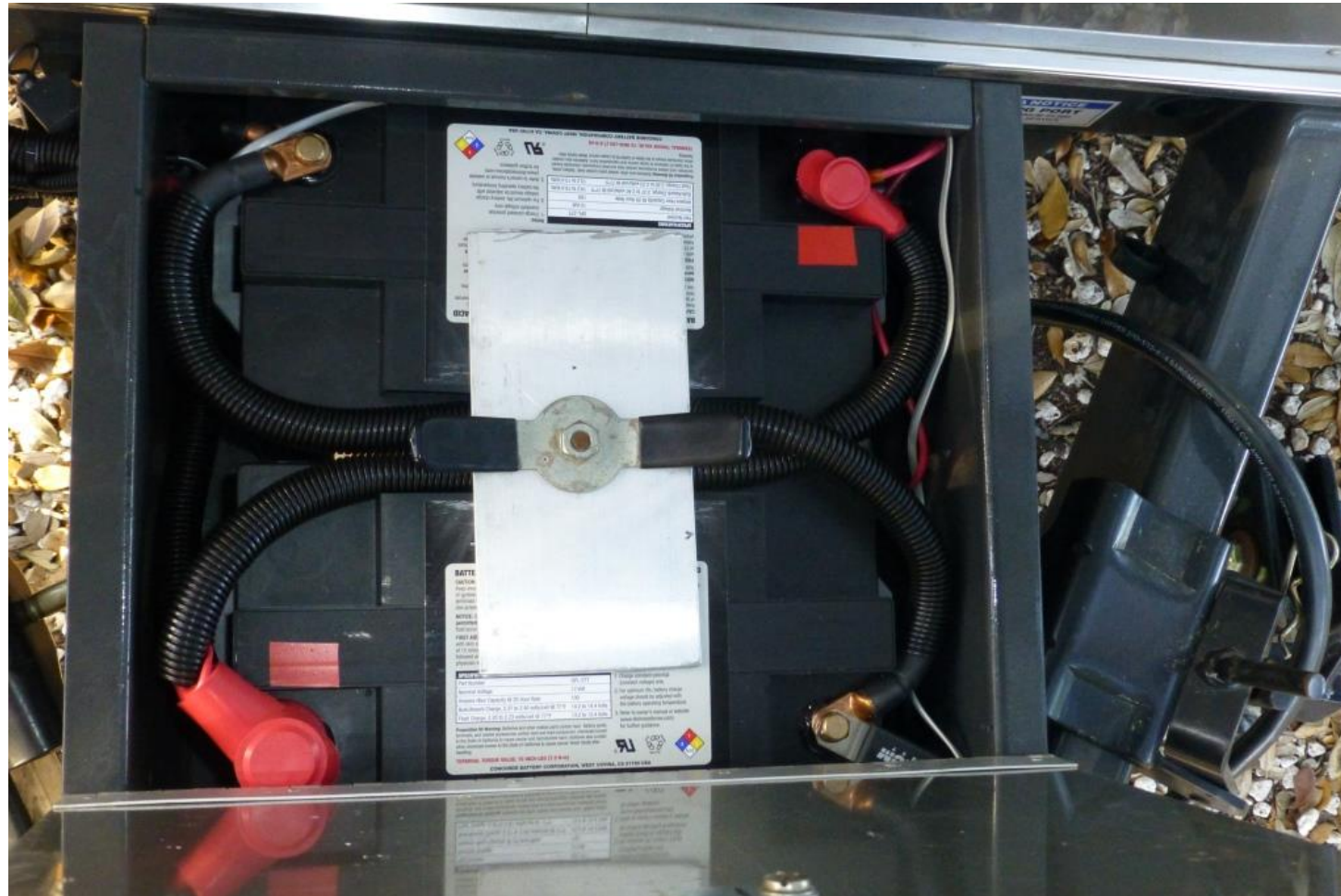
50% Increase L/A or AGM – 400% Lithium

Group 24 to GC2

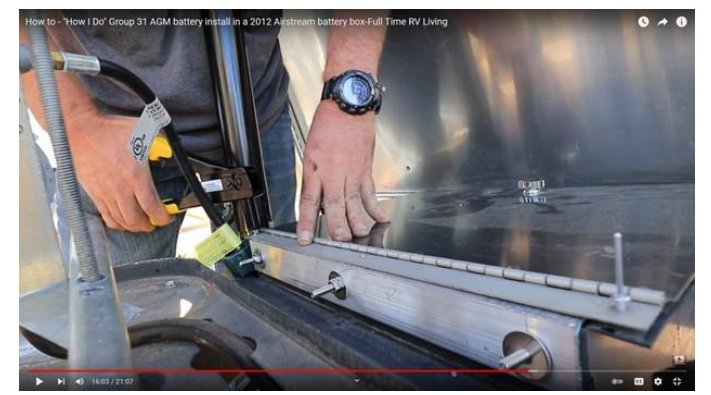
200% Increase L/A or AGM – 400% Lithium

3) Do Both 1 & 2

Upgrade to Group 27 Batteries



Upgrade to Group 31 Batteries



Upgrade to 6 Volt GC2 Batteries



Lead Acid Battery Sources 1/28/2022

<u>Source</u>	<u>Size (Group)</u>	<u>List Price</u>	<u>Reserve Amps</u>	<u>Ampere Hours</u>
Walmart	24	\$ 79.87	130	54
	29	\$ 89.97	195	81
	GC2 (6V)	\$ 104.97	N/A	224
Interstate	24	\$ 124.95	140	58
	27	\$ 134.95	160	67
	31	\$ 159.95	210	87
	GC2 (6V)	\$ 163.95	N/A	225
Costco	24	\$ 73.99	140	58
	27	\$ 81.99	160	67
	GC2 (6V)	\$ 89.99	N/A	210
Sams Club	24	\$ 74.74	120	50
	27	\$ 81.88	175	73
	31	\$ 99.90	190	79

AGM Battery Sources 1/28/2022

<u>Source</u>	<u>Size (Group)</u>	<u>List Price</u>	<u>Reserve Amps</u>	<u>Ampere Hours</u>
Walmart	24	\$ 118.90	132	55
	27	\$ 294.97	164	68
	31	\$ 344.99	224	93
	GC2 (6V)	\$ 349.99	N/A	235
Sams Club	24	\$ 119.32	132	55
	27	\$ 158.88	175	73
	31	\$ 179.74	210	88
Interstate	24	\$ 210.95	140	58
	31	\$ 354.95	200	83
	GC2 (6V)	\$ 341.95	N/A	210

Lithium (LiFeP04) Battery Sources 2/23/2022

<u>Source</u>	<u>Size (Group)</u>	<u>List Price</u>	<u>Ampere Hours</u>
<u>Non Heated</u>			
ECO-WORTHY	24	\$ 349.99	100
Mighty Max Battery	24	\$ 399.95	75
RELiON	24	\$ 862.95	75
ChargeX	24	\$ 949.99	75
Battle Born	24	\$ 675.00	75
Power Sonic	27	\$ 828.94	100
Renogy	27	\$ 699.99	100
		(Bluetooth)	
JITA	31	\$ 338.00	100
BtrPower	31	\$ 349.88	100
Ampere Time	31	\$ 369.99	100
CHINS	31	\$ 339.99	100
<u>Heated</u> (to Charge Below Freezing Temps)			
Renogy	27	\$ 899.00	100
Battle Born	31	\$ 875.00	100
Battle Born	GC2 (12V)	\$ 859.00	100
		\$ 899.00	100
		(With Switch Kit)	

Battery Testing

Test Results with Battery at 80 Degrees Fahrenheit

Charge Level	Specific Gravity L/A	Voltage L/A	Voltage AGM	Voltage Lithium
100%	1.265	>12.65	>12.75	14.34
80%	1.249	12.42	12.50	13.27
60%	1.197	12.20	12.26	13.13
40%	1.183	11.90	11.95	13.10
20%	1.148	11.58	11.66	12.87
10%	1.120	11.31	11.51	12.73
0%	1.073	10.50	10.50	10.24*

*** BMS Disconnects Battery Below This Level**

Lead Acid and AGM Battery Testing

HOW TO TEST

- Fully charge batteries
- Disconnect all loads
- Separate batteries (For dual batteries)
- Let sit for at least 4 hours to remove surface charge

NOTES

- If greater than 0.05 difference in Specific Gravity you have a bad cell (L/A Only)
- If Specific Gravity is less than 1.225 you have a bad battery (L/A Only)
- If the voltage is less than 70% or 12.3V on either a Lead Acid or AGM, you have a bad battery

How Long Does Will It Take to Charge?

- A rule of thumb for determining how long it will take to charge a fully depleted Lead Acid or AGM battery with a multi-stage charger is to divide the Amp Hours of the battery or total of the batteries by the maximum current rating of the charger.
- This will be how long it will take to charge the battery to an 80% level. The remaining 20% will take almost the same amount of time.
- For instance, if you have two fully depleted 55 AH batteries in parallel you have 110 AH required.
- If your Converter/Charger puts out a maximum of 55 Amps dividing 110 AH by that gives 2 hours for the first 80% and to get to 100% you need to double that for a total of 4 hours.

Trickle Chargers Vs Float Chargers

Trickle chargers apply a fixed voltage of 13.2 Volts

For Lead Acid batteries disconnect from Shore Power for long storage

- or check Electrolyte level regularly

Not recommended for AGM batteries.

Float chargers apply on-and-off 13.2 Volts as needed to maintain full charge

Suitable for Lead Acid and AGM Batteries

Can Remain Plugged-In to Shore Power Indefinitely

Charging From Tow Vehicle

- The charge voltage available to the trailer is regulated by the charge level of the battery in the tow vehicle not the charge level of the trailer battery(s).
- Although the charge connection (Pin 4) is usually a 30 Amp fused circuit, when the tow vehicle battery is fully charged the voltage drops from 14.4 volts to 13.4 volts.
- When measured, typically **only 5 Amps are available** to charge depleted trailer battery(s).
- For a trailer with two 55 AH batteries discharged to 50% it would take about 11 hours of driving to fully recharge the batteries.

When going to Lithium battery(s) Pin 4 must be disconnected (remove fuse) to avoid draining the battery(s) through the tow vehicle when it is not running.

Early Airstream Electrical History

1940s 120 VAC Lights and Receptacles

1950s Added 6 or 12 VDC Lights (Depending on tow vehicle) and optional battery
Dual Voltage System
120 VAC for Refrigerator, Water Heater, Vent Fans, Receptacles, Lighting
6 VDC or 12 VDC for secondary Lighting

1962-63 Vent Fans, Heater Fan switchable to run on installed 120/19 VAC transformer or 12 VDC

1964 Univolt "Power Center" added, transformed 120 VAC to 19 VAC and 12 VAC
Fan motors run at 19 VAC or 12 VDC
Lighting runs on 12 VAC or 12 VDC

1965 Univolt "**Converter**", converted 120 VAC to 12 VDC
All lighting and motors changed to 12 VDC

1968 Battery charger added to Univolt Power Center

1980s Began using Parallax Converters

Converters and Battery Chargers

SINGLE STAGE (1965 – 2006)*

Univolt, Parallax 6335, 6345, and Early Parallax 7355s

13.5-13.8 Volts

**Not suitable for AGM batteries*

2-STAGE (After 2006)*

Later Parallax 7355s and All 8355s & 5055s

14.4 Volts Stage 1 (Bulk Charge – Until 80%)

13.2 Volts Stage 2 (Trickle Charge)

**Not recommended for AGM batteries*

3-STAGE (After 2018) Airstream also began using 2X 6 Volt GC2 Batteries

WFCO 8955, 9855 Plastic Body

14.4 Volts Stage 1 (Bulk Charge – Until 80%)

13.6 Volts Stage 2 (Absorption Charge – Until 95%)

13.2 Volts Stage 3 (Float – Maintain 100%)

Converters and Battery Chargers

4-STAGE “Fully Automatic” Desulfation charger (*Not installed in Airstreams, Upgrades available*)

Stages 1 -3 Same as 3-Stage charger

Stage 4 – Higher voltage pulse to stir chemistry and knock loose sulfur off the plates

Typically: A steady or oscillating short pulse about once daily

Internal 4 Stage chargers are limited to 14.4 Volt pulse to protect installed electronics

External 4 Stage chargers typically pulse at a higher, more effective 15.8V – 22 Volts

Repair or Upgrade Converter or Charger Section

Progressive Dynamics

Upgrade Parallax to 4-Stage charger (\$260)

Upgrade Parallax to Lithium (\$337)

Upgrade WFCO to 4-Stage charger (\$218)

WFCO

Replacement 3-Stage 8955 Power Center for Early Parallax (\$169)

Upgrade to Lithium (\$189)

Power Max “Boondocker”

Upgrade WFCO to 4-Stage (\$179)

Note: Prices from Amazon 1/25/2022

Conversion of 7455 to 4-Stage with PD4655



4-Stage External Battery Chargers at Amazon

Need to disconnect battery from trailer to operate properly

Amazon.com : desulfation battery chargers

https://smile.amazon.com/s?k=desulfation+battery+chargers&crd=34...

Amazon.com : desulfation battery chargers

https://smile.amazon.com/s?k=desulfation+battery+chargers&crd=34...

Delivery
Today by 3PM
Overnight by 8AM
All Prime

Delivery Day
Get it Today
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Department
Automotive Tools & Equipment
Battery Chargers
Automotive Replacement Parts
Automotive Replacement Batteries & Accessories
Automotive Performance Parts & Accessories
Toys & Games
Industrial & Scientific
Skates, Skateboards & Scooters
See All 9 Departments

Customer Reviews
& Up
& Up
& Up
& Up

Brand
NOCO
Schumacher
CTEK

Price
Under \$25
\$25 to \$50
\$50 to \$100
\$100 to \$200
\$200 & Above

Min Max Go

Deals & Discounts
All Discounts


International Shipping
International Shipping Eligible


Condition
New
Used


Availability
Include Out of Stock

Showing results for *desulfation battery charger*
Search instead for [desulfation battery chargers](#)


RESULTS


 **NOCO GENIUS10, 10-Amp Fully-Automatic Smart Charger, 6V and 12V Battery Charger, Battery Maintainer,...**
9,232
\$99⁹⁵ \$124.95
Today 10 AM - 3 PM
FREE delivery today
More Buying Choices
\$91.95 (11 used & new offers)


 **TowerTop Battery Charger, 2/10/25Amp 12V Fully Automatic Smart Trickle Charger, Automotive Battery...**
4,066
\$144⁴⁹ \$199.99
Save \$25.00 with coupon
Overnight 4 AM - 8 AM
FREE delivery overnight


 **NOCO GENIUS5, 5-Amp Fully-Automatic Smart Charger, 6V and 12V Battery Charger, Battery Maintainer, Trickle...**
9,613
\$69⁹⁵ \$89.95
Today 10 AM - 3 PM
FREE delivery today
More Buying Choices
\$61.56 (18 used & new offers)


MORE RESULTS


 **Schumacher SC1281 100 Amp 30 Amp 6V/12V Fully Automatic Smart Battery Charger 100A Engine Starter...**
7,173
\$95⁹⁴
Overnight 4 AM - 8 AM
FREE delivery overnight
More Buying Choices
\$84.18 (7 used & new offers)


 **NOCO GENIUS1, 1-Amp Fully-Automatic Smart Charger, 6V and 12V Battery Charger, Battery Maintainer, Trickle...**
25,716
\$29⁹⁵ \$39.95
Today 10 AM - 3 PM
FREE delivery today on qualifying orders over \$35
More Buying Choices
\$26.36 (10 used & new offers)


 **NOCO GENIUS2X4, 4-Bank, 8-Amp (2-Amp Per Bank) Fully-Automatic Smart Charger, 6V And 12V Battery...**
590
Limited time deal
\$170⁰⁰ \$249.95
Today 10 AM - 3 PM
FREE delivery today
More Buying Choices
\$153.85 (6 used & new offers)

 **NOCO Genius GENPRO10X2, 2-Bank, 20-Amp (10-Amp Per Bank) Fully-Automatic Smart Marine Charger, 12V...**
551
\$193⁷⁴ \$249.95
Overnight 4 AM - 8 AM
FREE delivery overnight
More Buying Choices
\$183.95 (4 used & new offers)

 **NOCO GENIUSPRO25, 25-Amp Fully-Automatic Professional Smart Charger, 6V, 12V and 24V Battery...**
191
\$499⁹⁹
FREE One-Day
Get it Tomorrow, Jan 31
More Buying Choices
\$499.95 (3 new offers)

 **NOCO GENIUSPRO50, 50-Amp Fully-Automatic Professional Smart Charger, 6V, 12V and 24V Battery...**
193
\$768²⁷
FREE Delivery Tue, Feb 1

 **Clore Automotive PL2320 20-Amp Fully-Automatic Smart Charger, 6V and 12V Battery Charger, Battery Maintainer,...**
1,030
\$79⁹⁹ \$114.40
Overnight 4 AM - 8 AM
FREE delivery overnight
More Buying Choices
\$73.59 (11 used & new offers)

 **NOCO GENIUS2X2, 2-Bank, 4-Amp (2-Amp Per Bank) Fully-Automatic Smart Charger, 6V and 12V Battery...**
1,466
\$72¹⁴ \$124.95
Overnight 4 AM - 8 AM
FREE delivery overnight
More Buying Choices

Airstream “Power Plus” Options for 2021

- No solar package - Choose your trailer batteries at the dealership.
- Select solar package from factory - Trailer ships with Victron solar controller and battery monitor, 2 AGM batteries, and respective solar panel(s).
- Optional (\$3000 - \$4000) dealer-installed upgrade to replace batteries with 2 Battle Born 100 AH heated LiFePO4 Lithium batteries and upgraded power converter.

Can I Use My Existing Charger for Lithium Batteries?

- Yes, it worked fine for me.
- No, it will damage the battery(s)!
- Maybe, it depends on the charger and -

Will only charge to about 80% capacity

Cannot use a Desulfation charger

Must disconnect charger after battery is fully charged

- *Why risk it! It is not expensive to upgrade to a Lithium charger.*

END