

Portable and Emergency Power with LiFePO4 Batteries

Dale Henninger – WODHZ

Before we start...

I am a hobbyist... Not an electrical engineer.

Be Safe!

- Wear eye protection
- Invest in non-conductive tools
- Use Kapton/Polyimide Insulating Tape
 (heat resistant / non-conductive)

Read manufacturer data sheets!

Use fuses! High quality fuses!









Bioenno Power has donated batteries to the convention as door prizes.

They did not ask for me to promote their batteries and were not aware that I am doing this presentation.

I personally use Bioenno Power batteries as well as other brands of LiFePO4 batteries.

Bioenno Power has been very gracious to the amateur radio hobby, and I have received excellent customer service, which is why I continue to use their products.



Ham Radio and Batteries

Direct Current!

RF Quiet

Emergency Communications

Off Grid Operations

Great for portable use (POTA/SOTA)



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Ham Radio and Batteries

Your rig is only as good as your power source!

Radios require a 13.8 v power source (+/- 15%) 11.73 v - 15.87 v

Battery needs to deliver a current that can sustain the power level you are trying to operate at, with no reduction in voltage.

100w = ~ 17 Amps





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Battery Review





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Battery Chemistries





as of yet, elements 113-118 have no official name designated by the IUPAC.
 1 kJ/mol = 96.485 eV.
 all elements are implied to have an oxidation state of zero.

138.9054 57 538.1 1.10 Lanthanum	140.116 534.4 1.12 58 Cerium	140.9076 59 527.0 1.13 Pr Proseodymium	144.242 533.1 1.14 60 Nd Neodymium	(145) 61 Pm Promethium	Samarium 150.36 544.5 1.17 62	151.964 63 547.1 3 EU Europium	157.25 593.4 1.20 64 Godolinium	158.9253 65 565.8 Terbium	162.500 573.0 1.22 66 Dysprosium	164.9303 67 581.0 1.23 67 HO Holmium	167.259 589.3 1.24 68 Erbium	168.9342 69 596.7 1.25 69 Tmm Thulium	173.054 70 603.4 70 Ytherbium
(227) 499.0 1.10 Actinium (Rn) 6d ⁹ 75 ⁰	Piel 44' 5d' 64' 232.0380 90 587.0 1.30 Thh Thorium (Rn) 6d' 74'	231.0358 91 568.0 1.50 Pa Protactinium (kn) 5F 6d1 7x ²	Pail 4% det 238.0289 92 597.6 1.38 Uranium [Roj 5P 6df 7s ²	1237) 604.5 1.36 Neptuhium (Ko) 5 ¹⁴ 60 ¹ 79 ²	(244) 584.7 1.28 PU Plutonium (Ro) 5 th 7x ²	(243) 95 578.0 1.30 Americium *** (bit) 57' 7x* ***	(247) 581.0 1.30 Curium (Kn) 5P 6d' 75 ²	(247) 601.0 1.30 97 Berkelium (0) 5 th 7s ²	(251) 98 (251) 98 Californium (Ro) 51° 76°	(252) 619.0 1.30 99 ES Einsteinium (Kn) 51'' 62 ⁹	(257) 627.0 1.30 Fermium Jooj 5fr2 7y ²	(258) 101 635.0 1.30 Mendelevium (kn) 5f*7xP	(259) 642.0 1.30 Nobelium (Ro) 5f* 7e ³



Battery Chemistries – Lead Acid



Lead (Pb) Sulfuric Acid (H / S / O)

AGM – Improves the design –

increases the costs



																		18
4	H						T	he	Per	iodi	c To	able	e of	the	Ele	eme	nts	4.002602 2 2372.3 2
	Hydrogen	2	or most st	atomic mas	55.8	345 2	6- atc	mic number	alkal	i metals	etalloi metalloi	ds	13	14	15	14	17	Helium 14
	520.2 0.98 J	9.012182 4 899.5 1.57	1st ioniz	ation energy	762.5	1.83 -	ele	ctronegativit	ty 📃 alkal	ine metals	nonmete	als	10.811 5	12.0107 6	14.0067 1402.3 3.04	15.9994 8	8.998403 9 81.0 3.98	20.1797 10
2	Lithium 14 ¹ 24 ¹	Be Beryllium	cher	nical symbol	F	е	+5 +4 +3 +2		other	r metals ition metals	halogen	ases	Boron Ist ² 2s ² 2p ¹	Carbon 14 ¹ 24 ² 2p ²	N Nitrogen 14° 24° 2p°	O _{xygen}	uorine 1247 2p ⁸	Neon 14º 24º 2p ⁴
	22.98976 1 1 495.8 0.93	24.3050 737.7 1.31 12		name	Iron		-1- oxi	dation states	s 📃 lanth	anoids	unknow	n elements	26.98153 13 577.5 1.61	28.0855 1.90 14	30.97696 1	32.065 999.6 2.58 6	5.453 17	39.948 18 1520.6
3	Na	Magnessium	electron c	onfiguration		¹⁶ 4s ²	7	8	o actin	oids 10	radioactive masses in po	elements have arenthesis 12	Aluminium	Silicon	Phosphorus	S _{Sulfer}	C	Ar
	39.0983 19	40.078 20	44.95591 21	47.867 22	50.9415 23	51.9962 24	54.93804 25	55.845 26	58.93319 27	58.6934 28	63.546 29	65.38 30	69.723 3]	72.64 32	74.92160 33	78.96 34	79.904 35	83.798 36
4	418.8 0.82 ···	589.8 1.00	633.1 1.36 S C	658.8 1.54	650.9 1.63	652.9 1.66	Mn #	Fo	760.4 1.91	737.1 1.88	745.5 1.90	706.4 1.65 "	G G	G	947.0 2.18	So 3	Rr :	1350.8 3.00 ···
	Potassium (Ar) 4s ¹	Calcium [Ar] 4s ³	Scandium (Ar) 3d ¹ 4s ²	Titanium (Ai) 3d ¹ 4s ²	Vanadium (Ar) 3d ⁹ 4s ²	Chromium	Manganese [Ar] 3d ³ 4s ²	I C 1	Cobalt (Ar) 3d ² 4s ²	Nickel (Ar) 3d* 4s ²	Copper (Ar) 3d ^{ra} 4s ¹	Zinc [Ar] 3d ^{re} 4s ^t	Gallium [Ar] 3d ⁽⁰ 4s ² 4p ¹	Germanium (Ar) 3d ¹⁰ 4s ² 4p ²	Arsenic [Ar] 3d ¹⁰ 4s ¹ 4p ³	Selenium M 38** 45* 45*	Bromine (Ar) 3d ¹⁰ 4s ² 4p ³	Krypton [Ar] 3d ¹⁰ 4s ² 4p ⁶
	85.4678 37	87.62 549.5 0.95 38	88.90585 39	91.224 40 640.1 1.33	92.90638 41	95.96 42	(98) 43	101.07 44	102.9055 45	106.42 46	107.8682 47	112.441 48 867.8 1.69	114.818 49 558.3 1.78	118.710 50 708.6 1.96	121.760 51 834.0 2.05	127.60 52 869.3 2.10	126.9044 53	131.293 54
5	Rubidium Ind St	Sr Strontium	Yttrium (K) 4d' 5a ³	Zirconium	Niobium IICI 44* 55'	Molybdenum	Tc Technetium	Ruthenium	Rhodium	Pollodium Pollodium	Ag Silver	Cadmium Kej 4d ¹⁰ Sa ²	Indium (k) 4d ¹⁰ 5g ² 5g ²	Sn ª	Sb Antimony	Tellurium	lodine (k) 4d ¹⁰ 54 ² 59 ³	Xenon (K) 4d ¹⁶ 5p ² 5p ⁴
	132.9054 55	137.327 56	174.9668 71	178.49 72	180.9478 73	183.84 74	186.207 75	190.23 76	192.217 77	195.084 78	196.9665 79	200.59 80	204.3833 8	207.2 82	08.9804 83	(210) 84	(210) 85	(220) 86
6	Cs "	Ba	lu "	Hf	Ta	W	Re	Os	lr	Pt 4	Au	Ha #	TI	Ph [#]	Bi	Po	At	Rn
	Caesium Xe 64'	Barium (Xe) 60 ²	Lutetium (Xe) 4F* 5d* 6e ²	Hafnium (Ne) 4614 Sd2 647	Tantalum (Xe) 4814 Sd3 683	Tungsten	Rhenium 11 [Xe] 46* 5d* 6s ² -3	Osmium 13 [Xe] 4F* 5d* 6s ² -3	Iridium	Platinum (Ne) 4814 Sd* 661	Gold [Xe] 411* 5d1# 6s1	Mercury [Xe] 4114 Sd18 652	Thallium [Ke] 4F* Sd** 6s7 6p	Leod [Xe] 461* 5d1# 6s7 6p7	smuth 4F ¹⁴ Sd ¹⁰ 6s ² 6p ³	Polonium [Xe] 4114 Sd ¹⁰⁰ 64 ² 64 ⁴	Astatine Xe 4F* 5d** 6s* 6p*	Rodon [Xe] 41 ¹⁴ 5d ¹⁰ 6s ² 6p ⁴
	(223) 87	(226) 88	(262) 103	(261) 104	(262) 105	(266) 106	(264) 107	(277) 108	(268) 109	(271) 110	(272)]]]	(285) 112	(284) 113	(289) 114	(288) 115	(292) 116	117	(294) 118
7	Fr	Ra	Lr "	Rf "	Db "	Sa "	Bh "	Hs	Mt	Ds	Ra	Cn	Uut	Uua	Uup	Uuh	Uus	Uuo
	Francium	Radium	Lowrencium	Rutherfordium	Dubnium	Seaborgium	Bohrium	Hassium	Meitnerium	Darmstadium	Roentgenium	Copernicium	Ununtrium	Ununquodium	Ununpenfium	Ununhexium	Ununseptium	Ununoctium



138.9054 57 538.1 1.10	140.116 58	140.9076 59 527.0 1.13	144.242 60	(145) 61	150.36 62	151.964 63	157.25 593.4 1.20 64	158.9253 65 565.8	162.500 66	164.9303 67 581.0 1.23	167.259 68 589.3 1.24	168.9342 69	173.054 7 0
Lanthanum Kej 5d° 60 ²	Cerium pel 4f 5d 6s ³	Proseodymium	Neodymium (Ke) 41t 6s ¹	Promethium prej 41 th 68 ^t	Samarium Kel 4 th 60 [†]	EU Europium Xe 4f' 6s'	Gadolinium (Ke) 41° 5d° 64°	Terbium (Ke) 48 667	Dysprosium (Ke) 46 ¹⁸ 66 ²	Holmium [Ke] 4f ¹¹ 6s ²	Erbium [Ke] 4f ¹⁷ 6s ²	Thulium pel 40° 65°	Ytterbium (Xe) 4f ¹⁴ 6s ²
(227) 89	232.0380 90	231.0358 91	238.0289 92 597.6 1.38	(237) 93	(244) 94	(243) 578.0 1.30 95	(247) 96	(247) 97	(251) 98	(252) 99	(257) 1.30	(258) 101	(259) 102
Actinium	Thorium	Pa	Uranium	Np	PU Plutonium	Am Americium	Corium "	Bk	Californium	Es Einsteinium	Fermium	Md	No

Battery Chemistries – Lithium Ion / Lithium Polymer



Lithium Ion (Li Co O₂) Cobalt

Lithium Polymer (LiPo)





period 1	group 1 1.00794 1 1312.0 2.20 1 Hudrogen					_	T	he	Per	iodi	ic To	able	e of	the	Ele	eme	nts	18 4.002602 2 2372.3 Helium
	6.941 0.98 520.2 0.98 Lithium 1st 2st	2 012182 4 2.5 1.57 4 aryllium 124*	or most st 1 st ioniz cher	atomic mass able mass number ation energy in kJ/mo	-F	345 <u>1.83</u> <u>2</u> Э	6 atc +6 +5 +4 +3 +2 +1	omic number ctronegativit	ty alkali	i metals ine metals metals ition metals	metalloi	ds als ases	13 10.811 5 Boron 14*24*29*	14 12.0107 6 086.5 2.55 Carbon 14 ¹ 24 ¹ 24 ² 29 ²	1400067 1402.3 3.04 Nitrogen 14 ² 24 ² 24 ²	15:9994 8 Oxygen 14'24'24'	8.998403 9 810 3.98 -1 uorine 124'26 ⁵	20.1797 10 2080.7 10 Neon 16 ¹ 26 ¹ 26 ⁴
3	495.8 0.93	24.3050 737.7 1.31 Magnesrum (Ne) 347	electron c 3	name onfiguration 4		⁶ 4s ²	-1- OXI -2 mos	dation state: t common are bol	actine	anoids oids 10	radioactive of masses in po	n elements elements have arenthesis 12	26.98153 13 577.5 1.61 13 Aluminium [Ne] 35 ⁷ 3p ¹	28.0855 786.5 1.90 Silicon (Nel) 3a ² 3p ²	30.97696 15 1011.8 2.19 Phosphorus (Ne) 3x ² 3x ³	Sulfer (Ne) 3x ² 3p ⁴	35.453 1251.2 3.16 Chlorine (Nej 3e ³ 3p ⁸	39.948 18 1520.6 Argon [Ne] 3# ⁷ 3p ⁴
2	39.0983 418.8 0.82 Potassium (w) 44	40.078 20 589.8 1.00 20 Calcium	44.95591 21 633.1 1.36 Scandium (M) 3d' 44 ²	47.867 658.8 1.54 22 7 Titanium (M) 3d ¹ 4s ²	50.9415 650.9 1.63 Vanadium (4) 34' 44'	51.9962 24 Chromium (M) 34 ⁴ 45 ¹	54.93804 25 717.3 1.55 25 Manganese	55.845 762.5 1.83 20 Fe Iron (4) 3d ⁶ 45 ⁷	58.93319 27 Cobalt (M) 3d' 4s'	8.6934 28 37.1 1.88 28 Ni lickel r(3d ⁴ 45 ²	63.546 745.5 1.90 Copper (H) 3d ^{ia} 4s ⁱ	^{65.38} / ₉₀₆₄ 30 Zinc (M) 3d ¹⁰ 4s ¹	69.723 31 578.8 1.81 31 Gallium (kd) 3d ¹⁰ 4s ² 4p ³	72.64 762.0 2.01 32 Germanium (M) 3d ¹⁰ 45 ² 45 ²	74.92160 33 947.0 2.18 Arsenic (M) 3d ¹⁰ 45 ² 49 ³	78.96 941.0 2.55 34 Selenium (M) 3d ¹⁰ 4e ² 4p ⁴	79.904 1199.9.2.96 Br Bromine (w) 3d ^m 44 ^o 44 ^s	83.798 1350.8 3.00 36 Krypton (M) 3d ⁿ 4s ² 4p ⁶
Ę	85.4678 37 403.0 0.82 37 Rubidium Koj 54	87.62 549.5 0.95 38 Strontium (K) 54 ²	88.90585 39 600.0 1.22 Yttrium JKI e4 52	91.224 640.1 1.33 Zirconium (K) 44 ¹ 54 ²	92.90638 41 652.1 1.60 Niobium	95.96 684.3 2.16 Molybdenum (Ic) 48 51'	(98) 702.0 1.90 43 Tc Technetium	101.07 710.2 2.20 Ruthenium (K) 447 51	102.9033 45 719.7 2.28 Rhodium (%) 44*51'	Pd Pollodium 106.42 46 Pd	107.8682 47 731.0 193 47 Silver (c) 4d ¹⁰ 55 ¹	112.441 48 67.8 1.69 Cadmium Kol 44 ¹⁰ 54 ¹	114.818 558.3 1.78 49 In Indium (K) 44° 59° 59°	118.710 50 708.6 1.96 50 Sn Tin (K) 4d ¹⁰ 54 ² 59 ²	121.760 51 834.0 2.05 51 Sb Antimony (%) 4d ¹⁰ 5s ² 5s ³	127.60 52 Tellurium (c) 4d ¹⁰ 5a ² 5p ⁴	126.9044 53 1008.4 2.66 53 lodine %] 4d ⁱⁿ 5s ² 5p ³	131.293 54 1170.4 2.60 54 Xenon (x) 4d ¹⁰ 59 ² 59 ⁴
ć	132.9054 55 375.7 0.79 Caesium (xe) 64'	137.327 502.9 0.89 56 Banum Jel 66 ³	174.9668 71 523.5 1.27 +3 LU Lutetium [Ke] 41** 5d* 6e ²	178.49 658.5 1.30 Hf Hafnium (ke) 46* 5d ² 6w ²	180.9478 73 761.0 1.50 73 Tantalum glej 4f* 5d* 6s*	183.84 74 770.0 2.36 74 W Tungsten JKel 41" 5d* 65 ²	186.207 760.0 1.90 Ree Rhenium [Xe] 41* 5d* 6s ²	190.23 76 0 2.20 76 0 5 0 5 0 5 0 5 0 5 0 5 0 5 0 5	192.217 77 880.0 2.20 77 Iridium 104 41* 5d' 6s'	195.084 78 870.0 2.28 78 Pt Platinum (ke) 46* 5d* 6s'	196.9665 79 890.1 2.54 AU Gold (Ke) 46* 5d** 6s'	200.59 1007.1 2.00 Hog Mercury (Ke) 46* 56* 66?	204.3833 81 589.4 1.62 1 Thallium (ke) 46* 56* 66* 66*	207.2 715.6 2.33 82 Pb Leod (Ke) 40* 5d* 66* 66*	208.9804 83 703.0 2.02 Bi Bismuth (Ke) 46* 56* 66* 66*	(210) 812.1 2.00 84 Polonium (Xe) 41* 5d* 6e* 6e*	(210) 890.0 2.20 85 Astatine Pel 41* 5d* 6x* 6p*	(220) 1037.0 86 Rn Radon 1041415 5d18 6a1 6p8
7	(223) 380.0 0.70 87 Francium (Roj 76'	(226) 509.3 0.90 88 Radium Radium	(262) 103 470.0 103 Lowrencium (Rn) 51 ⁽⁴ 76 ⁷ 76 ⁷)	(261) 104 seo.0 ** Rf Rutherfordium (Rn) 51** 6df 7x ²	(262) 105	(266) 106 Sg Seaborgium	(264) 107 Bh Bohrium	(277) 108 Hassium	(268) 109 Mt Meitnerium	⁽²⁷¹⁾ 110 Ds Darmstadium	(272) 111 Rg Roentgenium	(285) 112 Copernicium	(284) 113	⁽²⁸⁹⁾ 114	(288) 115 Ununpenfium	⁽²⁹²⁾ 116 Uuunhexium	117 UUS Ununseptium	(294) 118 Ununoctium



electron configuration blocks

138.9054 57 538.1 1.10 53 Lanthanum (Xe) 5d* 6e ²	140.116 534.4 1.12 Cerium ptel 4f' 5d* 64*	140.9076 59 527.0 1.13 Praseodymium gel 4P 64*	144.242 60 533.1 1.14 60 Neodymium Jeel 4f* 68 ¹	(145) 540.0 61 Pm Promethium Jiej 4 th 64 ³	150.36 544.5 1.17 Samarium _{[Xe] 4} % 64 ³	151.964 63 547.1 63 EU Europium (Xe) 40° 647	$\underset{[Xe] 4P}{\overset{157.25}{\underset{593.4}{\overset{120}{1.20}}}} 64$	158.9253 65 565.8 Tebium _{[Xe] 4% 667}	162.500 573.0 1.22 Dysprosium (xe) 44** 65°	164.9303 67 581.0 1.23 67 Holmium Kel 46° 65°	167.259 589.3 1.24 68 Erbium Jel 461 659	168.9342 69 596.7 1.25 69 Tm Thulium jkel 48'3 69	173.054 70 403.4 *3 Yherbium (Xe) 46* 65°
(227) 499.0 1.10 89 AC Actinium (Ro) 6df 76 ²	232.0380 90 587.0 1.30 90 Th Thorium (Rin 66' 76'	231.0358 91 568.0 1.50 Pa Protactinium (Rn) 5P 6d1 7x ²	238.0289 92 597.6 1.38 92 Uranium (Roj 5P.6d! 7s ²	(237) 604.5 1.36 93 Neptunium (Ro) 54* 66' 75*	$(244) \\ s_{84.7} \\ 1.28 \\ P_{0} \\ P_{0} \\ P_{0} \\ r_{1} \\ r_{2} \\ r_{3} \\ r_$	(243) 578.0 1.30 95 Americium (Raj 5/? 7a*	(247) 581.0 1.30 96 Curium (Ro) 5P 6d' 75°	(247) sol.0 1.30 97 Bk Berkelium (Ro) 54° 74°	${\displaystyle \bigcap_{\substack{s \in 8.0 \\ colliformium \\ R_0 \ 5^{10} \ 7\rho^0}}^{(251)} 98}$	(252) 619.0 1.30 99 Es Einsteinium (Ro) 51° 62°	(257) 527.0 1.30 100 Fermium (Ro) 51°2 78°	(258) 101 635.0 1.30 101 Mendelevium (Rn) 5(+74)	(259) 642.0 1.30 102 Nobelium (Raj 54* 74*

Battery Chemistries – Lithium Iron Phosphate



Lithium Iron Phosphate (Li Fe P O_4)





 all elements are implied to have an oxidation state of zero.

138.9054 57 538.1 1.10	140.116 58 534.4 1.12	140.9076 59 527.0 1.13	144.242 60	(145) 61	150.36 544.5 1.17 62	151.964 63 547.1	157.25 593.4 1.20 64	158.9253 65 565.8	162.500 66 573.0 1.22	164.9303 67 581.0 1.23	167.259 68 589.3 1.24	168.9342 69 596.7 1.25	173.054 70 603.4
La Lonthonum (Ke) Sd ⁺ 6s ²	Cerium Kei 4f' 5d' 6s ²	Proseodymium	Neodymium [Xe] 4 ¹⁺ 64 ¹	Pm Promethium (Se) 41 th 68 ^t	Samarium Kel 4 th 64 ^t	EU Europium [Xe] 4 ^{fr} 64 ⁷	Gadolinium (Xe) 4f' 5d' 6d ²	Terbium (Ke) 4 th 6a ^t	Dysprosium _{[Ve] 41th 64²}	Holmium Xe 4 ^{ft} 65 ²	Erbium (Ke) 4 ⁶¹⁷ 65 ²	Thulium Piel 48'2 692	Yfterbium Ple 46* 65°
(227) 89	232.0380 90 587.0 1.30	231.0358 91	238.0289 92 597.6 1.38	(237) 93	(244) 94	(243) 578.0 1.30 95	(247) 96	(247) 97	(251) 98	(252) 619.0 1.30 99	(257) 100	(258) 101	(259) 102
Actinium (Rn) 6d ¹ 7s ²	Thorium	Pa Protactinium (Rn) 5P 6d' 7e ²	Uranium [Rn] 5P-6d' 7e ²	Neptunium (Rn) 5/* 6d' 76"	Putonium (Rn) 5 th 75 ⁰	Americium (Ro) 50° 75°	Curium (Rn) 5P 6d' 79 ²	Berkelium (Rn) 5/4 739	Californium (Rn) 51 ¹⁰ 74 ⁰	Es Einsteinium (Ro) 50° 68°	Fermium (Rej 50°2 78°	Mendelevium (Rn) Sf ¹¹ 78 ⁰	Nobelium (Rn) 5f* 7e ⁸





My Test Suite

Battery Measurement/Testing Terms

Amateur Radio Effective Voltages – 11.73v minimum (-15% of 13.8v)

All my tests are conducted with a shut off voltage of 11.73v

Amp Hours (Ah) – Battery capacity measurement

Amps * Hours = Ah (30 Ah battery could deliver 1A for 30 hours or 30A for 1 Hour)

State of Charge – Measurement of hour much capacity is left in the battery 0-100%

Battery Technologies

Pros

• Cheap / Durable (abuse may shorten life span)

Cons

- Heavy (lowest energy density)
- Can only be discharged to about 50% of their rated capacity for peak life span (life span not that long)
- Voltage drops as you discharge
- Messy / Dangerous (AGM solves some of this)

Lead Acid / AGM Batteries

Group 27 AGM Deep Cycle

Specs

- 65 Pounds / 11" x 7.3" x 9.3"
- 150 Minutes of Reserve Capacity
- \$249.99
- Max/Peak Discharge: Hundreds of Amps

Power Density

51.5 Ah of Capacity > 11.73 volts

.79 Ah / Pound Power Density

\$4.85 / Ah

Deep Cycle Lead Acid / AGM Batteries

Reserve Capacity vs Amp Hour

Reserve capacity (RC)

Measures how long a battery can run before its voltage drops to a certain level. For example, a battery with a reserve capacity of 150 minutes can supply 25 amps for 150 minutes before the voltage drops to 10.5 volts. RC is a good indicator of how long a battery can power essential accessories if a vehicle's alternator fails.

Amp hours (Ah)

Measures how many amps a battery can produce in one hour. One ampere-hour is the amount of electric charge transferred by a steady current of one ampere for one hour

12V Sealer Battery Vo	l Lead Acid Itage Chart	12V Floode Battery Vo	d Lead Acid Itage Chart
Voltage	Capacity	Voltage	Capacity
12.89V	100%	12.64V	100%
12.78V	90%	12.53V	90%
12.65V	80%	12.41V	80%
12.51V	70%	12.29V	70%
12 41V	60%	12 18V	60%
12.23V	50%	12.07V	50%
12.11V	40%	11.9/V	40%
11.96V	30%	11.87V	30%
11.81V	20%	11.76V	20%
11./UV	10%	11.63V	10%
11.63V	0%	11.59V	0%

 $Ah = \frac{RC}{60} \times 25$

 $62.5 \text{ Ah} = \frac{150}{60} \times 25$ I only measure 51.5 Ah as I cutoff testing when I pass below 11.73v

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Group 27 Discharge Curve = 7A Load

Lead Acid Battery – Complex Charging Profile

Charging the battery to 80% happens quickly

The last 20% of the charge has to be done at a much slower rate to top off the battery

Specialized chargers are needed to effectively charge these batteries

Charging incorrectly will cause heat and you will boil your battery

Battery Technologies

Lithium Ion / Polymer

Pros

- ~500 Discharge Cycle Lifespan
- Lightweight (high energy density)

Cons

- Higher Cost
- Risk of Thermal Runaway / Swelling

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Battery Technologies

Lithium Iron Phosphate

Pros

- ~3000+ Discharge Cycle Lifespan
- Lightweight (high energy density)
- Able to utilize +90% of the stored energy
- Very Safe / Stable / Durable

Cons

• Higher Cost

LiFePO4 Batteries

Bioenno 40 Ah LiFePO4

Specs

- 10.4 Pounds / 8.4" x 6.3" / 3.2"
- \$359.99
- 40A Max Continuous Discharge
- Peak Discharge 80A (5 seconds)

Power Density

38.4 Ah of Capacity > 11.73 volts

3.7 Ah / Pound Power Density

\$9.38 / Ah

40Ah LiFePO4 = 7A Load

Battery Discharge Curve Comparison

AGM / Lead Acid – Easier to determine State of Charge – Voltage varies throughout the discharge cycle

LiFePO4 – Holds voltage until the end of the capacity

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Performance

Anatomy of a Lithium Iron Phosphate Battery

Battery Management System (BMS)

3.2V Prismatic Cells 4x = 12.8V (Nominal) (13.6V-14.4V Fully Charged)

WODHZ

DALY BMS

Anatomy of a LiFePO4 Battery

Battery Management System

BMS

- Protects cells against damage
- Protects against over discharge / over charging
- Provides low/high temperature protection
- Monitors operation of cells Monitors individual cell voltages to try to protect cells and try to maintain consistent SoC (state of charge between all cells)
- Passive Balancing (most common) vs Active Balancing

DALY BMS

State of Charge (SoC) Coulomb-Count Method

Coulomb Counting

Provides a relative State of Charge by measuring how much current is put in and taken out of a battery.

LiFePO4 Chargers How to Charge a LiFePO4

Constant Current / Constant Voltage

LiFePO4 chargers provide a constant voltage of 14.2 to 14.5 volts

Constant current should be regulated based on the size of the battery. Although you can charge at higher rates, to maximize the life span of your battery, it is generally accepted that you should not charge at anything higher the .2C of the batteries rated Ah capacity.

Look for the recommendation of your manufacturer

40 Ah Battery

40 * .2 = 8 A Charging Recommended @ 14.2 - 14.5v

Bioenno recommends 6 A charger (they do not have an 8 A model)

LiFePO4 Chargers AC Chargers

Manufacturer

Review the chargers that the manufacturer recommends for your battery and Ah rating.

Desktop Power Supplies

Look for a model that can support constant voltage and constant current settings.

LiFePO4 Chargers DC-DC Chargers

Charing your LiFePO4 batteries on the go

Allows you to charge your battery while in your car

LiFePO4 Chargers DIY DC-DC Chargers

Buck-Boost Converters

Provides a relative State of Charge by measuring how much current is put in and taken out of a battery.

Buck/Boost Input Voltage: 5-32V DC Output Current Continuous: 8A

\$15

Buck/Boost Input Voltage: 10-60V DC 1800 Watts 10A Output easy at 14.2 V

\$19

LiFePO4 Chargers Solar Chargers

Charge your battery for off grid use

Solar charge controllers can convert the power from a solar panel to a constant current/constant voltage that is compatible with your LiFePO4 battery

\$70

What Battery is Right for You?

QRP - 5w/10w

6Ah (3-6 Hours)

\$79.99

12Ah (6-12 Hours)

\$124.99

 QRO - 100w

 Image: Constrained and the second a

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Form Factors – Go Boxes

Key Take Aways

Do you research - look for reviews - cheap is not always bad...

Look for a battery with the following features

 Low Temperature Disconnect (if you can't get this, never charge when your battery is below 32F)

Charge your battery at .2c when possible

Store your battery for long periods at around 60% State of Charge

Batteries I have experience with (positive)

• Made (mostly) in the USA

 Best selection of sizes and form factors

- Lowest cost by a longshot
- Options for batteries with internal heaters for cold climates

YouTube Resources

DIY Solar with Will Prowse

https://www.youtube.com/ @WillProwse

Off-Grid Garage https://www.youtube.com/ @OffGridGarageAustralia

Other Resources

DC-DC Buck/Boost SEPIC Converter https://universal-solder.ca/automatic-dc-dc-sepic-converter-10a/

DC-DC Buck/Boost Converter – 1800w https://www.qskj.cc/shop/1941708-dc-dc-converter-1800w-30a-cc-cvstep-up-power-supply-module-qs-4884cccv-1800w-6704

Other Companies to Look At

Victron Energy Renogy

Genasun Solar Charge Controllers https://sunforgellc.com/product/gv-10/

Other Resources

Want to build your own battery?

https://shop.denco.enterprises/

Home / Products / Batteries / DenCo 12V 5.5Ah Flat Pack LiFePO4 Battery

Sale

DenCo 12V 5.5Ah Flat Pack LiFePO4 Battery

\$104.99 \$84.99

Whether it's powering a QRP transceiver, or a 50W VHF/UHF mobile transceiver, this is the battery for you!

This unit is a 12-volt 5.5 amp-hour custom hand-built DenCo Battery comprised of four 32650 LiFePO4 cells and a DenCo/Daly common port 20A BMS.

Categories: Batteries, Products

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Thank You!

I hope to see you in my log!

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