EnerSys
Power/Full Solutions

Technical Manual

SEVENTH EDITION

ODYSSEY®

THE EXTREME BATTERY

Publication No: US-ODY-TM-001 - April 2011

ODYSSEY®
THE EXTREME BATTERY

Preface to the Seventh Edition

The addition of new sizes to the ODYSSEY® battery family of premium batteries has necessitated this new edition. Just as in the previous editions of the battery guide, detailed performance data for the new batteries are included in this revision.

This edition provides an expanded treatment of the charging requirements for ODYSSEY batteries, including a detailed discussion of a three-step charge profile that will bring back a fully discharged battery in about 6 to 8 hours. Also discussed are design variations among chargers with this profile.

This edition also includes updated test data on ODYSSEY batteries.

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ODYSSEY®
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INTRODUCTION

The ODYSSEY® battery ingeniously uses absorbed glass mat (AGM) valve regulated lead acid (VRLA) technology to offer, in one package, the characteristics of two separate batteries. It can deep cycle as well as deliver serious cranking power - it is like an athlete who is both a champion long distance runner and an excellent sprinter. Traditional battery designs allow them to either deep cycle or provide high amperage discharges for applications such as engine starting. The ODYSSEY battery can support applications in either category. ODYSSEY batteries are capable of providing engine cranking pulses of up to 2,250A for 5 seconds at 25ºC (77ºF) as well as deliver 400 charge/discharge cycles to 80% depth of discharge (DOD) when properly charged. A typical starting, lighting and ignition (SLI) battery, for example, is designed to provide short-duration, high-amperage pulses; it performs poorly when repeatedly taken down to deep depths of discharge or if they are placed on a continuous trickle charge, such as when they are used to crank a backup generator. A traditional battery resembles either a sprinter or a long distance runner; an ODYSSEY battery will do both - provide short duration high amperage pulses or low rate, long duration drains.

WHY USE ODYSSEY® BATTERIES?

- **Guaranteed longer service life**

With an 8- to 12-year design life in float (emergency power) applications at 25°C (77°F) and a 3- to 10-year service life depending on the nature of the non-float applications, ODYSSEY batteries save you time and money because you do not have to replace them as often. Unlike other AGM VRLA batteries, the ODYSSEY battery is capable of delivering up to 400 cycles when discharged to 80% DOD and properly charged.

- **Longer storage life**

Unlike conventional batteries that need a recharge every 6 to 12 weeks, a fully charged ODYSSEY battery can be stored for up to 2 years at 25°C (77°F) from a full state of charge. At lower temperatures, storage times will be even longer.

- **Deep discharge recovery**

The ease with which an ODYSSEY battery can recover from a deep discharge is extraordinary. A later section on storage and recharge criteria discusses test data on this important topic.

- **Superior cranking and fast charge capability**

The cranking power of ODYSSEY batteries is double to triple that of equally sized conventional batteries, even when the temperature is as low as -40°C (-40ºF). In addition, with simple constant voltage charging there is no need to limit the inrush current, allowing the battery to be rapidly charged. Please see the section titled *Rapid charging of ODYSSEY batteries* for more details on this feature.

- **Easy shipping**

The AGM valve-regulated design of the ODYSSEY battery eliminates the need for vent tubes; further, no battery watering is required and there is no fear of acid burns or damage to expensive chrome or paint. Because of the starved electrolyte design, the ODYSSEY battery has been proven to meet the US Department of Transportation (USDOT) criteria for a non-spillable battery. They can easily ship by highway, air or sea as specified on our MSDS sheet that can be found at **www.odysseybattery.com.**

- **Tough construction**

The rugged construction of the ODYSSEY battery makes it suitable for use in a variety of environments ranging from vacuum to 2 atmospheres (29.4 PSI).

- **Mounting flexibility**

Installing the ODYSSEY battery in any orientation does not affect any performance attribute, except for the PC1800 battery which should be installed right side up. There is also no fear of acid spillage. However, inverted installation is not recommended.

- **Superior vibration resistance**

ODYSSEY batteries have passed a variety of rigorous tests that demonstrate their ruggedness and exceptional tolerance of mechanical abuse. Please see the section titled *Shock, impact and vibration testing* for more details on these tests.

- **Ready out of the box**

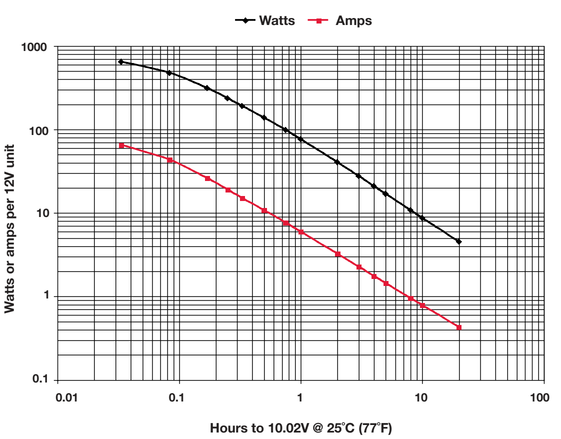
ODYSSEY batteries ship from the factory fully charged. If the battery's open circuit voltage is higher than 12.65V, simply install it in your vehicle and you are ready to go; if below 12.65V boost charge the battery following the instructions in this manual or the owner's manual. For optimum reliability, a boost charge prior to installation is recommended, regardless of the battery's open circuit voltage (OCV).

EXTENDED DISCHARGE CHARACTERISTICS

In addition to its excellent pulse discharge capabilities, the ODYSSEY® battery can deliver many deep discharge cycles, yet another area where the ODYSSEY battery outperforms a conventional SLI battery, which can deliver only a few deep discharge cycles.

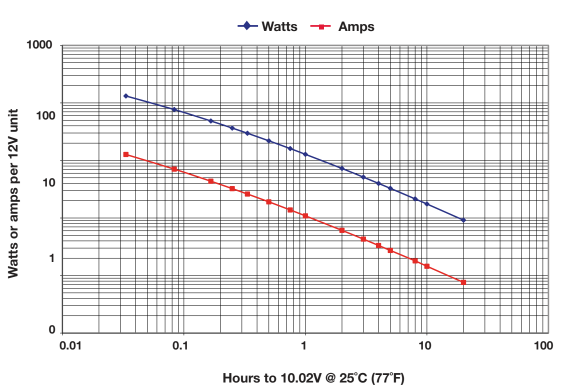
The following twenty graphs show detailed discharge characteristics of the entire ODYSSEY battery line. The end of discharge voltage in each case is 10.02V per battery or 1.67 volts per cell (VPC). Each graph shows both constant current (CC) and constant power (CP) discharge curves at 25ºC (77ºF). The table next to each graph shows the corresponding energy and power densities. The battery run times extend from 2 minutes to 20 hours.

PC310 & ER8 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/liter	Wh/liter	W/kg	Wh/kg
2 min	738	80.8	2.7	24.6	613.2	20.4	273.3	9.1
5 min	473	43.2	3.6	39.4	393.3	32.8	175.3	14.6
10 min	312	26.0	4.4	53.1	259.4	44.1	115.6	19.7
15 min	236	19.0	4.8	59.0	196.0	49.0	87.4	21.8
20 min	191	15.0	5.0	62.9	158.4	52.3	70.6	23.3
30 min	139	10.8	5.4	69.3	115.1	57.6	51.3	25.7
45 min	98	7.6	5.7	73.9	81.8	61.4	36.5	27.4
1 hr	76	6.0	6.0	76.4	63.5	63.5	28.3	28.3
2 hr	41	3.2	6.5	81.0	33.7	67.3	15.0	30.0
3 hr	28	2.3	6.8	82.8	22.9	68.8	10.2	30.7
4 hr	21	1.8	7.0	83.7	17.4	69.6	7.8	31.0
5 hr	17	1.4	7.2	84.5	14.0	70.2	6.3	31.3
8 hr	11	0.9	7.6	86.1	8.9	71.5	4.0	31.9
10 hr	9	0.8	7.8	86.8	7.2	72.1	3.2	32.2
20 hr	5	0.4	8.6	90.5	3.8	75.2	1.7	33.5

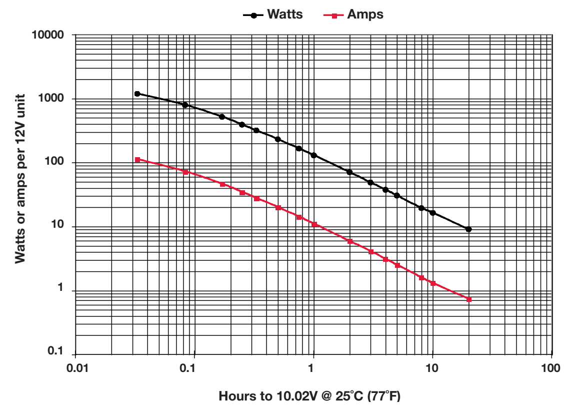
ER15 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/litre	Wh/litre	W/kg	Wh/kg
2 min	1320	127.1	4.2	44.0	612.2	20.4	231.6	7.7
5 min	768	70.7	5.9	64.0	356.2	29.7	134.7	11.2
10 min	485	43.6	7.3	80.9	225.1	37.5	85.2	14.2
15 min	365	32.4	8.1	91.4	169.5	42.4	64.1	16.0
20 min	297	26.1	8.7	99.0	137.8	45.9	52.1	17.4
30 min	220	19.1	9.6	109.8	101.9	50.9	38.5	19.3
45 min	161	13.8	10.4	120.6	74.6	55.9	28.2	21.2
1 hr	128	10.9	10.9	127.8	59.3	59.3	22.4	22.4
2 hr	73	6.1	12.2	145.2	33.7	67.3	12.7	25.5
3 hr	51	4.3	12.9	153.7	23.8	71.3	9.0	27.0
4 hr	40	3.3	13.3	159.6	18.5	74.0	7.0	28.0
5 hr	33	2.7	13.7	163.8	15.2	76.0	5.7	28.7
8 hr	21	1.8	14.4	171.8	10.0	79.7	3.8	30.1
10 hr	18	1.5	14.5	175.2	8.1	81.3	3.1	30.7
20 hr	9	0.8	15.2	183.6	4.3	85.2	1.6	32.2

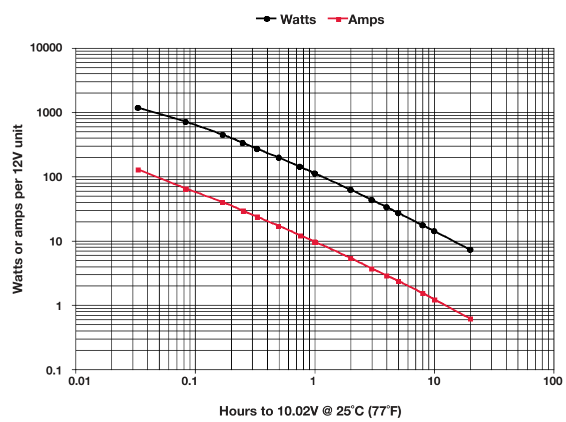
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/kg
2 min	1182	112.0	3.40	35.5	450.7	13.5	218.9	6.6
5 min	786	71.9	5.75	62.9	299.7	24.0	145.6	11.6
10 min	517.2	46.3	7.90	87.9	197.2	33.5	98.8	16.3
15 min	390.6	34.5	8.60	97.65	148.9	37.2	72.3	18.1
20 min	316.2	27.7	9.10	104.35	120.6	39.8	58.6	19.3
30 min	230.4	20.0	10.0	115.2	87.85	43.9	42.7	21.3
45 min	165	14.2	10.65	123.75	62.9	47.2	30.6	22.9
1 hr	129	11.0	11.0	129.0	49.2	49.2	23.9	23.9
2 hr	70.2	5.9	11.8	140.4	26.8	53.5	13.0	26.0
3 hr	48.5	4.1	12.3	145.4	18.5	55.5	9.0	26.9
4 hr	37.3	3.1	12.4	149.3	14.2	56.9	6.9	27.6
5 hr	30.5	2.5	12.5	152.4	11.6	58.1	5.6	28.2
8 hr	19.9	1.7	13.6	159.4	7.6	60.8	3.7	29.5
10 hr	16.3	1.3	13.0	163.2	6.2	62.2	3.0	30.2
20 hr	9	0.74	14.8	178.8	3.4	68.2	1.7	33.1

PC535 & ER18 performance data at 25°C, per 12V module



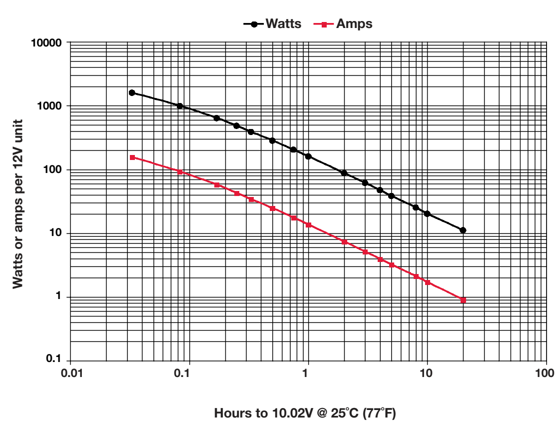
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/kg
2 min	1361	128.1	4.3	45.3	680.8	22.7	238.7	8.0
5 min	648	64.4	5.4	54.0	324.2	27.0	113.7	9.5
10 min	415	39.6	6.7	70.6	207.75	35.3	72.8	12.4
15 min	313	29.2	7.3	78.2	156.4	39.1	54.8	13.7
20 min	254	23.5	7.8	83.8	127.0	41.9	44.5	14.7
30 min	187	16.9	8.5	93.3	93.4	46.7	32.7	16.4
45 min	136	12.2	9.2	101.7	67.9	50.9	23.8	17.8
1 hr	107	9.6	9.6	107.4	53.7	53.7	18.8	18.8
2 hr	60	5.3	10.6	120.0	30.0	60.0	10.5	21.1
3 hr	42	3.7	11.1	126.0	21.0	63.1	7.4	22.1
4 hr	32	2.9	11.6	129.6	16.2	64.9	5.7	22.7
5 hr	26	2.3	11.5	132.0	13.2	66.1	4.6	23.2
8 hr	17	1.5	12.0	134.4	8.4	67.25	3.0	23.6
10 hr	14	1.2	12.0	138.0	6.9	69.1	2.4	24.2
20 hr	7	0.7	14.0	144.0	3.6	72.1	1.3	25.3

PC545 & ER20 performance data at 25°C, per 12V module

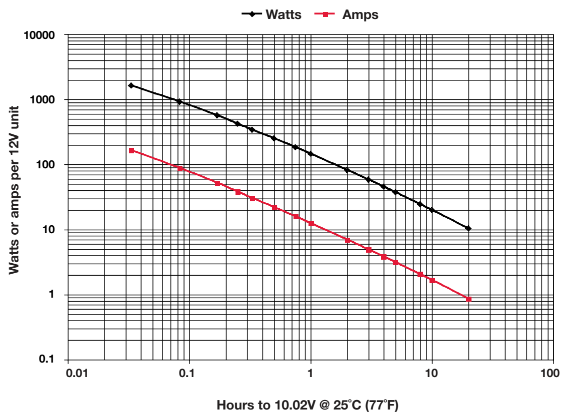


Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/kg
2 min	1582	154.7	5.20	52.70	536.10	17.90	255.10	8.50
5 min	986	91.6	7.60	82.20	334.35	27.90	159.10	13.30
10 min	635	57.1	9.50	105.90	215.40	35.90	102.50	17.10
15 min	478	42.3	10.60	119.40	161.90	40.50	77.0	19.30
20 min	385	33.8	11.30	128.40	130.60	43.50	62.10	20.70
30 min	281	24.4	12.20	140.70	95.40	47.70	45.40	22.70
45 min	202	17.4	13.05	151.65	68.50	51.40	32.60	24.50
1 hr	159	13.6	13.60	159.0	53.90	53.90	25.65	25.65
2 hr	87	7.3	14.60	174.0	29.50	59.0	14.0	28.10
3 hr	61	5.1	15.30	181.80	20.50	61.60	9.80	29.30
4 hr	47	3.9	15.60	187.20	15.90	63.45	7.55	30.20
5 hr	38	3.2	16.0	192.0	13.0	65.10	6.20	31.0
8 hr	25	2.1	16.80	201.60	8.50	68.30	4.10	32.50
10 hr	20	1.7	17.0	204.0	6.90	69.15	3.30	32.90
20 hr	11	0.9	18.0	216.0	3.70	73.20	1.70	34.80

PC625 & ER22 performance data at 25°C, per 12V module

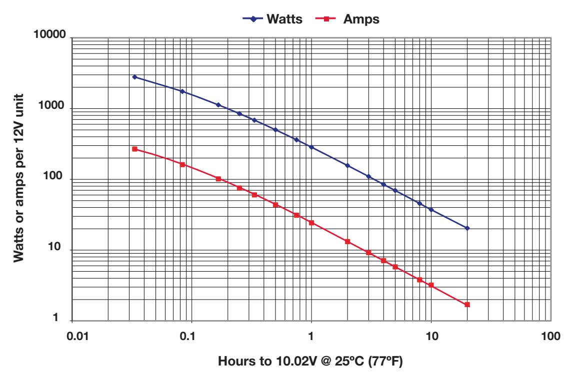


PC680 & ER25 performance data at 25°C, per 12V module



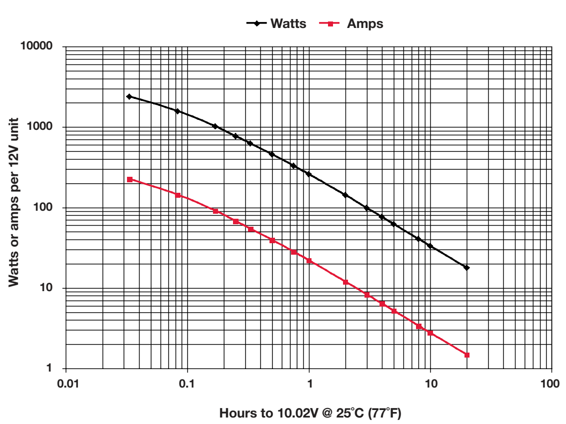
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/liter	Wh/liter	W/kg	Wh/kg
2 min	1486	143.0	4.8	49.5	601.4	20.0	212.3	7.1
5 min	792	78.8	6.6	66.0	320.5	26.7	113.1	9.4
10 min	512	49.3	8.4	87.1	207.3	35.25	73.2	12.4
15 min	389	36.7	9.2	97.4	157.6	39.4	55.6	13.9
20 min	318	29.6	9.8	104.9	128.7	42.5	45.4	15.0
30 min	236	21.6	10.8	118.2	95.7	47.8	33.8	16.9
45 min	173	15.6	11.7	130.1	70.2	52.6	24.8	18.6
1 hr	138	12.3	12.3	138.0	55.8	55.8	19.7	19.7
2 hr	79	6.9	13.8	157.2	31.8	63.6	11.2	22.5
3 hr	56	4.8	14.4	166.5	22.5	67.4	7.9	23.8
4 hr	43	3.7	14.8	172.8	17.5	69.9	6.2	24.7
5 hr	35	3.0	15.0	177.0	14.3	71.6	5.1	25.3
8 hr	23	2.0	16.0	187.2	9.5	75.75	3.3	26.7
10 hr	19	1.6	16.0	192.0	7.8	77.7	2.7	27.4
20 hr	10	0.8	16.0	204.0	4.1	82.6	1.5	29.1

ER30 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/litre	Wh/litre	W/kg	Wh/kg
2 min	2793.6	268.3	8.9	93.1	755.0	25.2	310.4	10.3
5 min	1744.8	161.3	13.4	145.4	471.6	39.3	193.9	16.2
10 min	1126.2	101.4	16.9	187.7	304.4	50.7	125.1	20.9
15 min	847.8	75.3	18.8	212.0	229.1	57.3	94.2	23.6
20 min	685.8	60.3	20.1	228.6	185.4	61.8	76.2	25.4
30 min	501.6	43.6	21.8	250.8	135.6	67.8	55.7	27.9
45 min	361.8	31.1	23.3	271.4	97.8	73.3	40.2	30.2
1 hr	284.4	24.3	24.3	284.4	76.9	76.9	31.6	31.6
2 hr	156.6	13.2	26.4	313.2	42.3	84.6	17.4	34.8
3 hr	109.8	9.2	27.6	329.4	29.7	89.0	12.2	36.6
4 hr	84.6	7.1	28.4	338.4	22.9	91.5	9.4	37.6
5 hr	69.6	5.8	29.0	348.0	18.8	94.1	7.7	38.7
8 hr	45.6	3.8	30.4	364.8	12.3	98.6	5.1	40.5
10 hr	37.2	3.2	32.0	372.0	10.1	100.5	4.1	41.3
20 hr	20.4	1.7	34.0	408.0	5.5	110.3	2.3	45.3

PC925 & ER35 performance data at 25°C, per 12V module

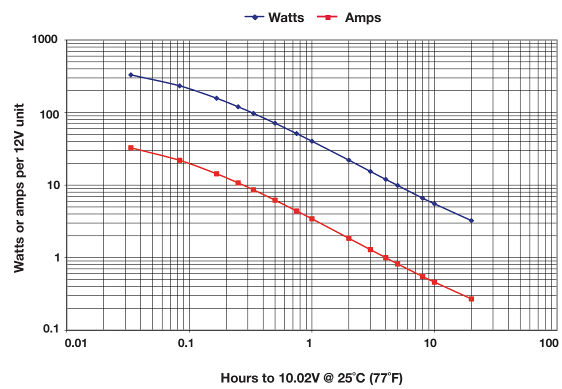


Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/liter	Wh/liter	W/kg	Wh/kg
2 min	2381	224.8	7.5	79.3	615.8	20.5	201.8	6.7
5 min	1446	142.8	11.9	120.5	374.0	31.2	122.5	10.2
10 min	954	90.6	15.4	162.2	246.75	42.0	80.9	13.7
15 min	726	67.4	16.9	181.5	187.8	46.9	61.5	15.4
20 min	592	54.2	17.9	195.2	153.0	50.5	50.1	16.5
30 min	436	39.2	19.6	217.8	112.7	56.3	36.9	18.5
45 min	316	28.1	21.1	236.7	81.6	61.2	26.75	20.1
1 hr	250	21.9	21.9	249.6	64.6	64.6	21.2	21.2
2 hr	138	11.9	23.8	276.0	35.7	71.4	11.7	23.4
3 hr	96	8.3	24.9	288.0	24.8	74.5	8.1	24.4
4 hr	74	6.4	25.6	297.6	19.2	77.0	6.3	25.2
5 hr	61	5.2	26.0	303.0	15.7	78.4	5.1	25.7
8 hr	40	3.4	27.2	316.8	10.2	81.9	3.4	26.9
10 hr	32	2.8	27.5	324.0	8.4	83.8	2.75	27.5
20 hr	17	1.5	30.0	348.0	4.5	90.0	1.5	29.5

ODYSSEY®
THE EXTREME BATTERY

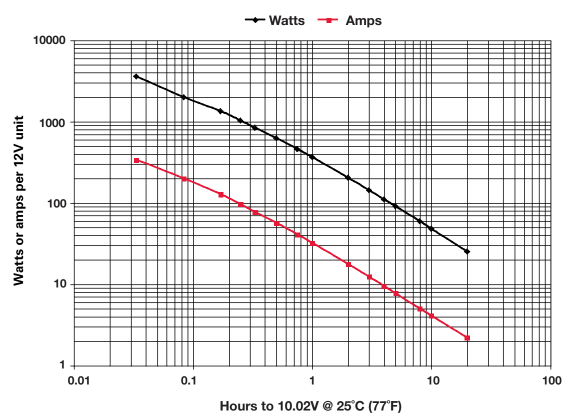
ER40 performance data at 25°C, per 12V module

Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/litre	Wh/litre	W/kg	Wh/kg
2 min	3307.2	326.8	10.9	110.2	668.1	22.3	264.6	8.8
5 min	2332.8	219.5	18.3	194.4	471.3	39.3	186.6	15.6
10 min	1575.0	143.2	23.9	262.5	318.2	53.0	126.0	21.0
15 min	1200.0	107.2	26.8	300.0	242.4	60.6	96.0	24.0
20 min	974.4	86.1	28.7	324.8	196.8	65.6	78.0	26.0
30 min	713.4	62.0	31.0	356.7	144.1	72.1	57.1	28.5
45 min	513.0	44.0	33.0	384.8	103.6	77.7	41.0	30.8
1 hr	402.6	34.3	34.3	402.6	81.3	81.3	32.2	32.2
2 hr	220.8	18.5	37.0	441.6	44.6	89.2	17.7	35.3
3 hr	154.2	12.9	38.7	462.6	31.2	93.5	12.3	37.0
4 hr	120.0	10.0	40.0	480.0	24.2	97.0	9.6	38.4
5 hr	99.0	8.2	41.0	495.0	20.0	100.0	7.9	39.6
8 hr	66.0	5.5	44.0	528.0	13.3	106.7	5.3	42.2
10 hr	55.2	4.6	46.0	552.0	11.2	111.5	4.4	44.2
20 hr	32.4	2.7	54.0	648.0	6.5	130.9	2.6	51.8



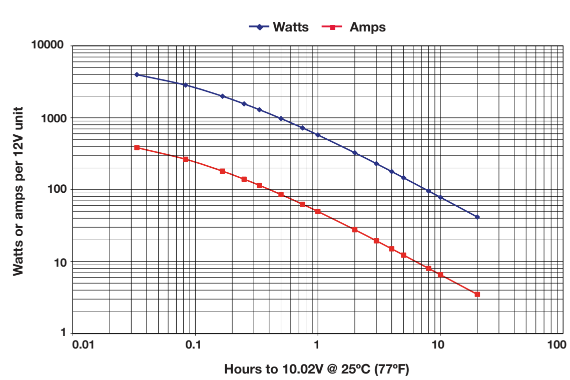
PC1200 performance data at 25°C, per 12V module

Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/kg
2 min	3580	337.9	11.3	119.2	613.0	20.4	205.8	6.9
5 min	1992	199.1	16.6	165.9	341.1	28.4	114.5	9.5
10 min	1338	127.9	21.7	227.5	229.1	38.9	76.9	13.1
15 min	1026	96.0	24.0	256.5	175.7	43.9	59.0	14.7
20 min	840	77.5	25.6	277.2	143.8	47.5	48.3	15.9
30 min	624	56.6	28.3	312.0	106.8	53.4	35.9	17.9
45 min	458	40.8	30.6	343.4	78.4	58.8	26.3	19.7
1 hr	364	32.1	32.1	363.6	62.25	62.25	20.9	20.9
2 hr	203	17.7	35.4	406.8	34.8	69.7	11.7	23.4
3 hr	143	12.3	36.9	428.4	24.5	73.4	8.2	24.6
4 hr	110	9.5	38.0	441.6	18.9	75.6	6.3	25.4
5 hr	91	7.7	38.5	453.0	15.5	77.6	5.2	26.0
8 hr	59	5.0	40.0	475.2	10.2	81.4	3.4	27.3
10 hr	48	4.1	41.0	480.0	8.2	82.2	2.8	27.6
20 hr	25	2.2	44.0	504.0	4.3	86.3	1.5	29.0

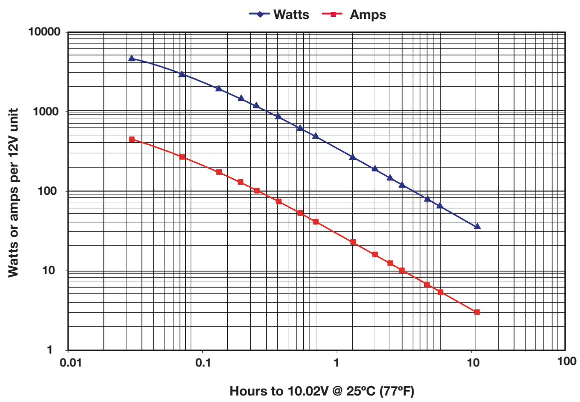


PC1220 performance data at 25°C, per 12V module

Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/litre	Wh/litre	W/kg	Wh/kg
2 min	3982	384.3	12.8	132.7	396.6	13.2	192.4	6.4
5 min	2846	264.8	22.1	237.2	283.5	23.6	137.5	11.5
10 min	1993	180.8	30.1	332.1	198.5	33.1	96.3	16.0
15 min	1561	139.7	34.9	390.3	155.5	38.9	75.4	18.9
20 min	1294	114.8	38.3	431.4	128.9	43.0	62.5	20.8
30 min	976	85.5	42.8	487.9	97.2	48.6	47.1	23.6
45 min	722	62.6	46.9	541.2	71.9	53.9	34.9	26.1
1 hr	577	49.7	49.7	576.6	57.4	57.4	27.9	27.9
2 hr	326	27.7	55.4	652.1	32.5	64.9	15.8	31.5
3 hr	230	19.4	58.3	689.8	22.9	68.7	11.1	33.3
4 hr	179	15.0	60.1	714.0	17.8	71.1	8.6	34.5
5 hr	146	12.3	61.5	731.6	14.6	72.9	7.1	35.3
8 hr	96	8.0	64.2	766.2	9.5	76.3	4.6	37.0
10 hr	78	6.5	65.5	782.0	7.8	77.9	3.8	37.8
20 hr	42	3.5	69.9	832.1	4.1	82.9	2.0	40.2

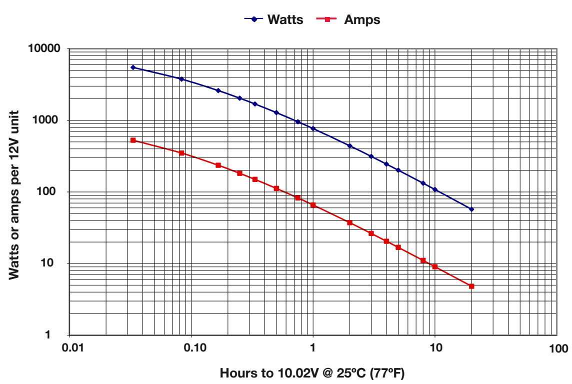


75-PC1230 & 75/86-PC1230 performance data at 25°C, per 12V module



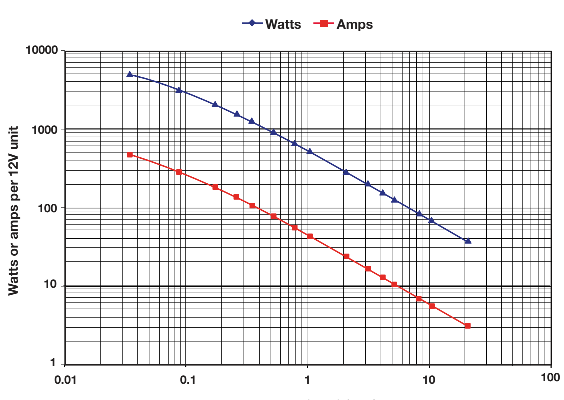
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/litre	Wh/litre	W/kg	Wh/kg
2 min	4561.7	432.9	14.3	150.5	531.5	17.5	221.4	7.3
5 min	2936.3	266.5	22.1	243.7	342.1	28.4	142.5	11.8
10 min	1919.1	169.6	28.3	320.5	223.6	37.3	93.2	15.6
15 min	1451.2	126.6	31.7	362.8	169.1	42.3	70.4	17.6
20 min	1176.0	101.8	33.9	391.6	137.0	45.6	57.1	19.0
30 min	861.5	73.8	36.9	430.8	100.4	50.2	41.8	20.9
45 min	621.9	52.8	39.6	466.4	72.5	54.3	30.2	22.6
1 hr	489.8	41.4	41.4	489.8	57.1	57.1	23.8	23.8
2 hr	270.1	22.6	45.3	540.2	31.5	62.9	13.1	26.2
3 hr	189.0	15.8	47.4	567.1	22.0	66.1	9.2	27.5
4 hr	146.4	12.2	48.8	585.7	17.1	68.2	7.1	28.4
5 hr	120.1	10.0	50.0	600.6	14.0	70.0	5.8	29.2
8 hr	79.2	6.6	52.7	633.2	9.2	73.8	3.8	30.7
10 hr	65.0	5.4	54.1	650.1	7.6	75.7	3.2	31.6
20 hr	35.7	3.0	59.4	713.5	4.2	83.1	1.7	34.6

PC1350 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/litre	Wh/litre	W/kg	Wh/kg
2 min	5477.3	527.2	17.6	182.6	438.2	14.6	199.9	6.7
5 min	3758.2	349.4	29.1	313.2	300.7	25.1	137.2	11.4
10 min	2601.6	235.8	39.3	433.6	208.1	34.7	94.9	15.8
15 min	2037.0	182.0	45.5	509.3	163.0	40.7	74.3	18.6
20 min	1691.9	149.8	49.9	564.0	135.4	45.1	61.7	20.6
30 min	1282.0	112.1	56.0	641.0	102.6	51.3	46.8	23.4
45 min	955.0	82.5	61.9	716.2	76.4	57.3	34.9	26.1
1 hr	767.6	65.8	65.8	767.6	61.4	61.4	28.0	28.0
2 hr	440.8	37.3	74.5	881.7	35.3	70.5	16.1	32.2
3 hr	313.6	26.4	79.1	940.8	25.1	75.3	11.4	34.3
4 hr	244.8	20.5	82.0	979.2	19.6	78.3	8.9	35.7
5 hr	201.4	16.8	84.2	1006.9	16.1	80.5	7.3	36.7
8 hr	132.5	11.1	88.5	1059.8	10.6	84.8	4.8	38.7
10 hr	108.3	9.0	90.5	1082.7	8.7	86.6	4.0	39.5
20 hr	57.3	4.8	96.5	1146.8	4.6	91.7	2.1	41.9

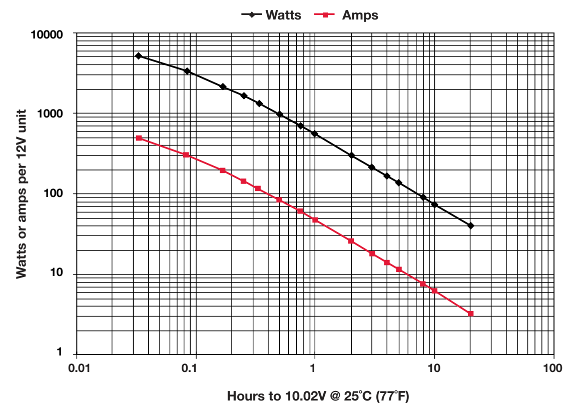
25-PC1400 & 35-PC1400 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/litre	Wh/litre	W/kg	Wh/kg
2 min	5308.3	499.5	16.5	175.2	576.1	19.0	233.8	7.7
5 min	3439.7	315.8	26.2	285.5	373.3	31.0	151.5	12.6
10 min	2261.4	203.0	33.9	377.7	245.4	41.0	99.6	16.6
15 min	1715.5	151.9	38.0	428.9	186.2	46.5	75.6	18.9
20 min	1393.0	122.2	40.7	463.9	151.2	50.3	61.4	20.4
30 min	1022.9	88.6	44.3	511.5	111.0	55.5	45.1	22.5
45 min	739.4	63.3	47.4	554.5	80.2	60.2	32.6	24.4
1 hr	582.5	49.4	49.4	582.5	63.2	63.2	25.7	25.7
2 hr	320.6	26.8	53.6	641.2	34.8	69.6	14.1	28.2
3 hr	223.7	18.6	55.7	671.0	24.3	72.8	9.9	29.6
4 hr	172.6	14.3	57.2	690.5	18.7	74.9	7.6	30.4
5 hr	141.1	11.7	58.4	705.4	15.3	76.5	6.2	31.1
8 hr	92.1	7.6	61.0	736.6	10.0	79.9	4.1	32.4
10 hr	75.2	6.2	62.5	751.9	8.2	81.6	3.3	33.1
20 hr	40.3	3.4	67.9	805.5	4.4	87.4	1.8	35.5

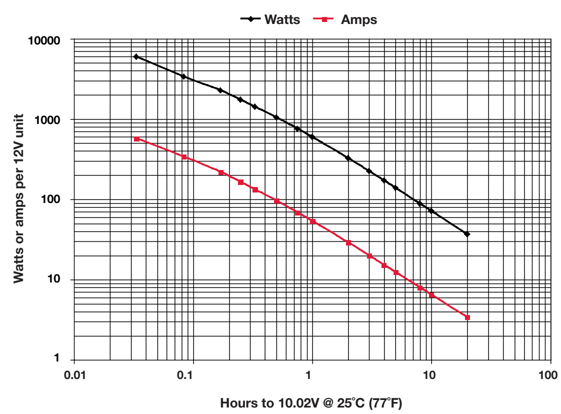
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/liter	Wh/liter	W/kg	Wh/kg
2 min	5228	494.8	16.3	172.5	538.1	17.8	209.9	6.9
5 min	3337	304.4	25.3	277.0	343.5	28.5	134.0	11.1
10 min	2175	193.6	32.3	363.3	223.9	37.4	87.4	14.6
15 min	1644	144.5	36.1	411.0	169.2	42.3	66.0	16.5
20 min	1332	116.1	38.7	443.7	137.2	45.7	53.5	17.8
30 min	977	84.2	42.1	488.4	100.5	50.3	39.2	19.6
45 min	706	60.3	45.2	529.3	72.6	54.5	28.3	21.3
1 hr	556	47.3	47.3	556.2	57.3	57.3	22.3	22.3
2 hr	307	25.9	51.7	615.0	31.7	63.3	12.3	24.7
3 hr	215	18.1	54.2	646.5	22.2	66.5	8.7	26.0
4 hr	167	14.0	56.0	668.4	17.2	68.8	6.7	26.8
5 hr	137	11.5	57.4	685.4	14.1	70.6	5.5	27.5
8 hr	90	7.6	60.6	723.1	9.3	74.4	3.6	29.0
10 hr	74	6.2	62.3	742.5	7.6	76.4	3.0	29.8
20 hr	41	3.25	65.0	814.0	4.2	83.8	1.6	32.7

34-PC1500, 34R-PC1500, 34M-PC1500, 34/78-PC1500 & 78-PC1500 performance data at 25°C, per 12V module



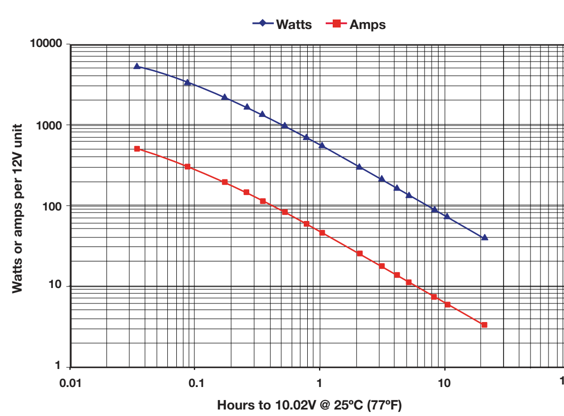
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/liter	Wh/liter	W/kg	Wh/kg
2 min	5942	569.8	19.0	197.9	607.0	20.2	215.3	7.2
5 min	3636	337.6	28.1	279.9	343.3	28.6	121.7	10.1
10 min	2411	218.5	37.2	384.5	231.1	39.3	82.0	13.9
15 min	1833	163.8	41.0	433.5	177.2	44.3	62.8	15.7
20 min	1490	132.6	43.7	467.3	144.7	47.7	51.3	16.9
30 min	1091	96.0	48.0	522.0	106.7	53.3	37.8	18.9
45 min	786	68.6	51.4	567.0	77.2	57.9	27.4	20.5
1 hr	615	53.6	53.6	594.6	60.75	60.75	21.5	21.5
2 hr	333	28.9	57.8	648.0	33.1	66.2	11.7	23.5
3 hr	229	19.9	59.6	671.4	22.9	68.6	8.1	24.3
4 hr	175	15.2	61.0	684.0	17.5	69.9	6.2	24.8
5 hr	142	12.4	61.8	693.0	14.2	70.8	5.0	25.1
8 hr	90	8.0	63.6	705.6	9.0	72.1	3.2	25.6
10 hr	73	6.5	64.5	714.0	7.3	72.9	2.6	25.9
20 hr	37	3.4	67.9	732.0	3.7	74.8	1.3	26.5

PC1700 performance data at 25°C, per 12V module

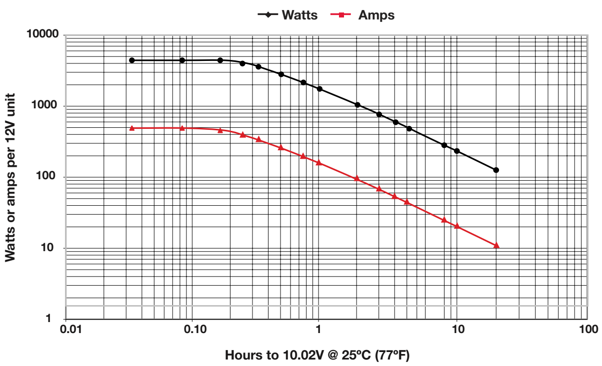


Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES			
					W/litre	Wh/litre	W/kg	Wh/kg
2 min	5890.3	565.9	18.7	194.4	567.9	18.7	224.0	7.4
5 min	3769.7	334.2	27.7	312.9	363.5	30.2	143.3	11.9
10 min	2439.6	210.9	35.2	407.4	235.2	39.3	92.8	15.5
15 min	1832.0	157.7	39.4	458.0	176.6	44.2	69.7	17.4
20 min	1477.1	127.2	42.4	491.9	142.4	47.4	56.2	18.7
30 min	1075.8	93.0	46.5	537.9	103.7	51.9	40.9	20.5
45 min	770.8	67.2	50.4	578.1	74.3	55.7	29.3	22.0
1 hr	604.6	53.0	53.0	604.6	58.2	58.3	23.0	23.0
2 hr	354.6	29.4	58.9	709.2	34.2	68.4	13.5	27.0
3 hr	252.0	20.7	62.0	756.0	24.3	72.9	9.6	28.7
4 hr	196.3	16.0	64.1	785.0	18.9	75.7	7.5	29.8
5 hr	160.9	13.1	65.7	804.6	15.5	77.6	6.1	30.6
8 hr	104.8	8.6	69.1	838.5	10.1	80.9	4.0	31.9
10 hr	85.0	7.1	70.6	850.3	8.2	82.0	3.2	32.3
20 hr	45.6	3.8	75.7	912.6	4.4	88.0	1.7	34.7

65-PC1750 performance data at 25°C, per 12V module

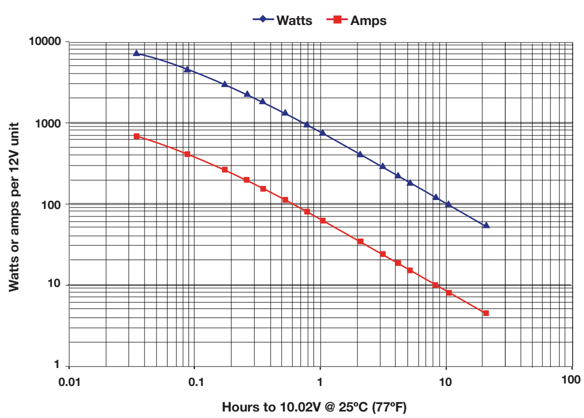


PC1800-FT performance data at 25°C, per 12V module



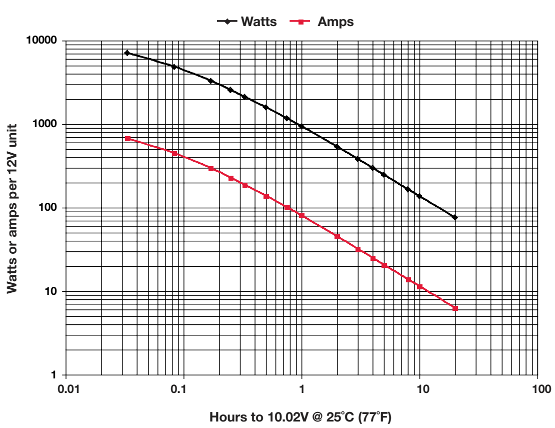
Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/Kg
2 min	4422	491.4	16.4	147.4	199.6	6.7	73.7	2.5
5 min	4422	491.2	40.9	368.5	199.6	16.6	73.7	6.1
10 min	4422	454.7	75.8	737.0	199.6	33.3	73.7	12.3
15 min	3984	373.3	93.3	996.0	179.8	44.9	66.4	16.6
20 min	3384	312.7	104.2	1128.0	152.7	50.9	56.4	18.8
30 min	2610	238.3	119.2	1305.0	117.8	58.9	43.5	21.8
45 min	1968	177.8	133.4	1476.0	88.8	66.6	32.8	24.6
1 hr	1590	143.1	143.1	1590.0	71.8	71.8	26.5	26.5
2 hr	936	82.2	164.4	1872.0	42.2	84.5	15.6	31.2
3 hr	666	58.3	174.9	1998.0	30.1	90.2	11.1	33.3
4 hr	522	45.4	181.6	2088.0	23.6	94.2	8.7	34.8
5 hr	426	37.3	186.5	2130.0	19.2	96.1	7.1	35.5
8 hr	282	24.6	196.8	2256.0	12.7	101.8	4.7	37.6
10 hr	234	20.2	202.0	2340.0	10.6	105.6	3.9	39.0
20 hr	126	10.9	218.0	2520.0	5.7	113.7	2.1	42.0

31-PC2150 & 31M-PC2150 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/Kg
2 min	7025	678.5	22.4	231.8	515.3	17.0	199.0	6.6
5 min	4740	438.5	36.4	393.4	347.7	28.9	134.3	11.1
10 min	3176	285.9	47.7	530.4	233.0	38.9	90.0	15.0
15 min	2428	215.5	53.9	607.0	178.1	44.5	68.8	17.2
20 min	1980	174.1	58.0	659.2	145.2	48.4	56.1	18.7
30 min	1460	127.0	63.5	730.0	107.1	53.5	41.4	20.7
45 min	1059	91.2	68.4	793.9	77.6	58.2	30.0	22.5
1 hr	835	71.5	71.5	835.2	61.3	61.3	23.7	23.7
2 hr	461	39.0	78.0	922.2	33.8	67.7	13.1	26.1
3 hr	322	27.1	81.4	966.8	23.6	70.9	9.1	27.4
4 hr	249	20.9	83.8	996.8	18.3	73.1	7.1	28.2
5 hr	204	17.1	85.6	1020.0	15.0	74.8	5.8	28.9
8 hr	134	11.2	89.7	1070.4	9.8	78.5	3.8	30.3
10 hr	110	9.2	91.9	1095.9	8.0	80.4	3.1	31.0
20 hr	60	5.0	100.3	1191.9	4.4	87.4	1.7	33.8

PC2250 performance data at 25°C, per 12V module



Time	Watts (W)	Amps (A)	Capacity (Ah)	Energy (Wh)	ENERGY AND POWER DENSITIES W/liter	Wh/liter	W/kg	Wh/kg
2 min	7090	671.6	22.4	236.1	1143.0	14.75	181.8	6.1
5 min	4820	443.8	37.0	401.5	301.2	25.1	123.6	10.3
10 min	3291	296.4	50.4	559.5	205.6	35.0	84.4	14.4
15 min	2553	227.1	56.8	638.3	159.5	39.9	65.5	16.4
20 min	2107	185.8	61.3	695.3	131.7	43.5	54.0	17.8
30 min	1583	137.9	69.0	791.5	98.9	49.5	40.6	20.3
45 min	1170	100.9	75.7	877.5	73.1	54.8	30.0	22.5
1 hr	937	80.2	80.2	937.0	58.6	58.6	24.0	24.0
2 hr	536	45.2	90.4	1072.0	33.5	67.0	13.7	27.5
3 hr	382	32.0	96.0	1146.0	23.9	71.6	9.8	29.4
4 hr	299	25.0	100.0	1196.0	18.7	74.7	7.7	30.7
5 hr	247	20.6	103.0	1235.0	15.4	77.2	6.3	31.7
8 hr	165	13.8	110.4	1320.0	10.3	82.5	4.2	33.9
10 hr	137	11.4	114.0	1370.0	8.6	85.6	3.5	35.1
20 hr	76	6.3	126.0	1520.0	4.75	95.0	2.0	39.0

PEUKERT'S EXPONENT

The capacity of a battery depends on the rate at which it is discharged. For example, the ODYSSEY® 31-PC2150 battery is rated at 92Ah when discharged at the 10-hour rate (9.2A for 10 hours) and 100Ah when discharged at the 20-hour rate (5.0A for 20 hours). This variability in battery capacity makes it problematic to estimate the support time one can expect for a given current draw. This is where the Peukert equation, shown below comes in handy.

$$\text{Capacity} = I^n \times t$$

$$n = \frac{\log T_2 - \log T_1}{\log I_1 - \log I_2}$$

In the first equation, *n* is called the Peukert's coefficient; I_1 and I_2 are two discharge current rates and T_1 and T_2 are the corresponding discharge durations. Knowing the rated capacity of the battery and the coefficient (given in the table below) one can use this equation to estimate the battery support time for a given amp draw.

Suppose you have a 15A load you want to run off the ODYSSEY 31-PC2150 battery, which is rated at 92Ah and you want to know *approximately* how long it will support the load. From the table below, *n* is 1.112 for the Group 31 battery; its capacity is 92Ah and I is 15A. Substituting these values into the Peukert equation yields a support time t of about 4-1/2 hours before the battery is fully depleted.

Table 1

ODYSSEY® Battery Model	Peukert Coefficient
PC310	1.072
PC535	1.078
PC545	1.107
PC625	1.107
PC680	1.129
PC925	1.100
PC1200	1.106
PC1220	1.132
75-PC1230 (all variations)	1.074

ODYSSEY® Battery Model	Peukert Coefficient
PC1350	1.147
25-PC1400 (all variations)	1.034
34-PC1500 (all variations)	1.133
PC1700	1.091
65-PC1750	1.081
PC1800-FT	1.150
31-PC2150 (all variations)	1.112
PC2250	1.180

Some battery monitoring systems (BMS) offer the option of entering the Peukert coefficient so that the BMS can estimate the time left for the battery to be fully discharged at a given discharge rate. If you have such a system, you can use the table above to find the value of your battery model. An important point to keep in mind here is that this estimation is valid only for an ambient temperature of 25°C (77°F).

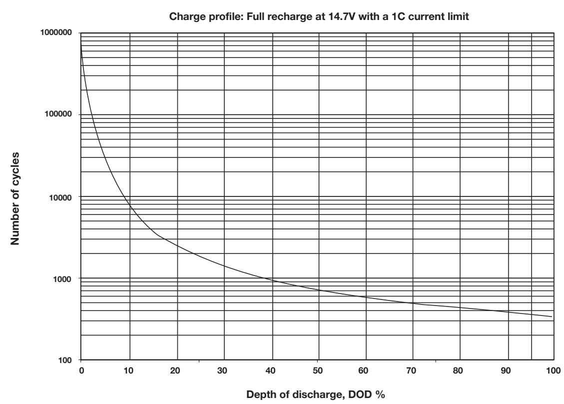
CYCLE LIFE AND DEPTH OF DISCHARGE (DOD)

Applications in which the battery is frequently discharged and recharged are called cyclic. A complete cycle starts with a charged battery that is discharged and then brought back to a full charge. Battery life in these applications is stated as the number of cycles the battery will deliver before its capacity drops to 80% of its rated value. For example, suppose a battery is rated at 100 amp-hours (Ah) and has a published cycle life of 400. This means that the battery can be cycled 400 times before its delivered capacity drops to 80Ah.

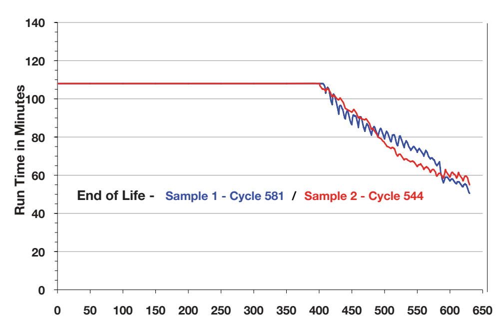
Proper charging and DOD are the two key factors that determine how many cycles a battery will deliver before it reaches end of life. The DOD is simply the ratio of capacity extracted from the battery to its rated capacity expressed as a percentage. If a 100Ah battery delivers 65Ah and then recharged it is said to have delivered a 65% DOD cycle.

The relationship between DOD and cycle life for ODYSSEY batteries is shown in Figure 1. The lower the DOD the higher the number of cycles the battery will deliver before reaching end of life.

Figure 1



The true dual purpose design of ODYSSEY batteries is reflected in the cycle life results shown in the graph below. The two ODYSSEY 65-PC1750 battery samples were discharged at 25A (the reserve capacity rate) for 108 minutes (80% of 135 minutes, which is the 100% rate for this battery), rested for an hour then charged for 5 hours at 14.7V with a 50A current limit. Since five hours are not sufficient to charge them completely, both batteries were given 20-hour charges every ten cycles. Sample 1 cycled 581 times and Sample 2 lasted 544 cycles before reaching end of life.



FLOAT LIFE

Float life refers to the life expectancy of a battery that is used primarily as a source of backup or emergency power. Emergency lighting, security alarm and uninterruptible power systems (UPS) are good examples of batteries in float applications. In each of these applications the battery is discharged only if the main utility power is lost; otherwise the battery remains on continuous trickle charge (also called float charge).

Since ODYSSEY® batteries are dual purpose by design, they offer a long-life battery option in float applications. At room temperature (77°F or 25°C) these batteries have a design life of 10+ years in float applications; at end of life an ODYSSEY battery will still deliver 80% of its rated capacity.

Heat is a killer of valve regulated lead acid (VRLA) absorbed glass mat (AGM) batteries such as ODYSSEY batteries and the rule of thumb that relates battery temperature to battery life is that *for every 8°C rise in battery temperature, the float life is cut in half.* This means that an ODYSSEY battery that has a 10-year float life at 25°C (77°F) will have only a 5-year life at 33°C (91°F) and a 2-1/2 year float life at 41°C (106°F). Therefore if your float application requires batteries to be in an uncontrolled temperature environment you should account for battery life that will be shorter than its design life at 25°C (77°F).

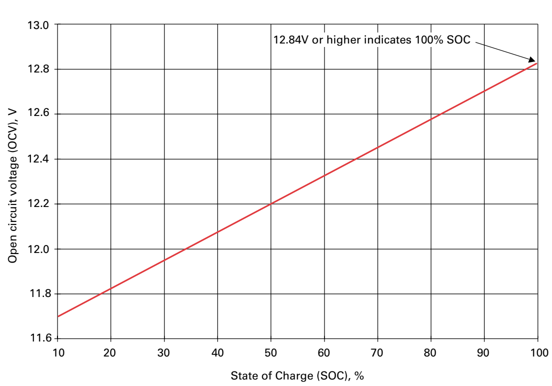
ODYSSEY® BATTERY STORAGE AND DEEP DISCHARGE RECOVERY

For any rechargeable battery, storage and recharge are important criteria. This section provides some guidelines that will help you get the most from your ODYSSEY battery.

(A) How do I know the state of charge (SOC) of the battery?

Use Figure 2 to determine the SOC of the ODYSSEY battery, as long as the battery has not been charged or discharged for six or more hours. The only tool needed is a good quality digital voltmeter to measure its open circuit voltage (OCV)[1]. The graph shows that a healthy, fully charged ODYSSEY battery will have an OCV of 12.84V or higher at 25°C (77°F).

Figure 2: Open circuit voltage and state of charge



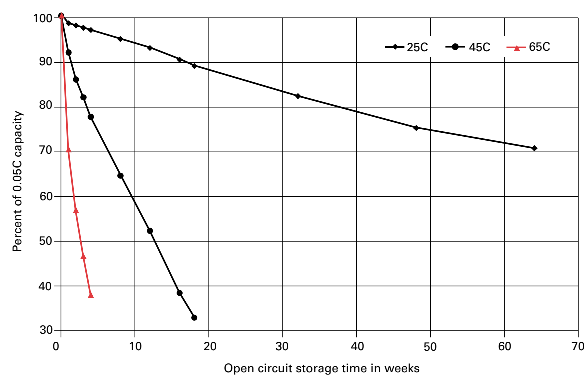
(B) How long can the battery be stored?

The graph below shows the shelf life of the ODYSSEY battery at different temperatures. At 25°C (77°F), these batteries can be stored for up to 2 years. The lower the temperature, the longer the storage time. *Charge the battery before storing it.*

The effect of temperature on storage is evident. Roughly, every 10°C (18°F) increase in temperature cuts the storage time in half. Thus, at 35°C (95°F) the battery may be stored for only 1 year before a recharge becomes necessary.

Figure 3 applies only to batteries that are fully charged before storage.

Figure 3: ODYSSEY® battery storage time at temperatures



(C) Can the battery recover from abusive storage conditions?

Yes, the ODYSSEY battery can recover from extremely deep discharges as the following test results demonstrate.

(1) German DIN standard test for overdischarge recovery

In this test, a PC925 was discharged over 20 hours ($0.05C_{10}$ rate)[2] to 10.20V. After the discharge[2] a 5**Ω** resistor was placed across the battery terminals and the battery kept in storage for 28 days.

At the end of the storage period, the battery was charged at 13.5V for only 48 hours. A second $0.05C_{10}$ discharge yielded 97% of rated capacity, indicating that a low rate 48-hour charge after such a deep discharge was insufficient; however, the intent of the test is to determine if the battery is recoverable from extremely deep discharges using only a standby float charger. A standard automotive charger at 14.4V would have allowed the battery to recover greater than 97% of its capacity.

These test results prove that ODYSSEY batteries can recover from abusive storage conditions. Reinforcing this conclusion is the next test, which is even harsher than the DIN standard test, because in this test the battery was stored in a discharged state at a temperature of 50°C (122°F).

[1]The OCV of a battery is the voltage measured between its positive and negative terminals without the battery connected to an external circuit (load). It is very important to take OCV reading only when the battery has been off charge for at least 6-8 hours, preferably overnight.

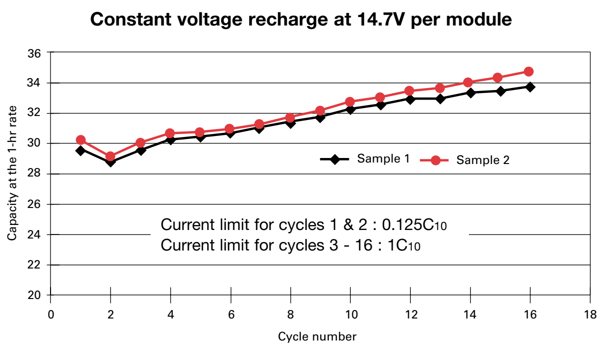
[2]The C_{10} rate of charge or discharge current in amperes is numerically equal to the rated capacity of a battery in ampere-hours at the 10-hour rate. Thus, a 26Ah battery at the 10-hour rate, such as the PC925 would have a C_{10} rate of 2.6A.

(2) High temperature discharged storage test

Two PC1200 samples were discharged in this test at the 1-hour rate to 9V per module, and then placed in storage at 50°C (122°F) in a *discharged condition* for 4 weeks.

At the end of 4 weeks, the two batteries were recharged using a constant voltage (CV) charge at 14.7V per battery. As Figure 4 below shows, both samples recovered from this extreme case of abusive storage.

Figure 4: Recovery from high temperature discharged storage



Deep Discharge Recovery Procedure

It is not unusual for batteries, particularly in automotive or other engine starting applications to get over discharged due to factors such as parasitic loads that drain batteries in vehicles that are not used for extended periods of time. Leaving a dome light on over a weekend can also have the same effect on a battery.

This section will describe two separate procedures to recover a deeply discharged ODYSSEY® battery. The first procedure is for the average consumer who only has access to a typical automotive charger for home use and sold in auto parts stores.

Procedure #2 should be attempted by someone who has access to more sophisticated charging equipment such as regulated DC power supplies and has the capability to safely discharge a battery using a controllable load bank.

Although over discharging a battery is not recommended, ODYSSEY batteries have a much higher level of tolerance for this kind of abuse than traditional starting, lighting and ignition (SLI) batteries. Should an ODYSSEY battery be over discharged and conventional charging techniques fail to recover it, the following protocols may be used to recover the battery. It is important to note that even if the battery recovers following implementation of either protocol, it may suffer some level of permanent damage.

Procedure #1

Since most typical automotive chargers for home use have a built-in safety feature that prevents them from turning on if the battery voltage is too low, this procedure may require the user to "jump" the dead battery to a healthy battery by connecting the positive of the dead battery to the positive of the healthy battery; similarly the negative of the dead battery must be connected to the negative of the healthy battery.

Once the two batteries are connected as described above the battery charger can be hooked up according to the charger manufacturer's procedure to the terminals of the dead battery. The dead battery should now start accepting a charge.

Continue charging for a while, then unplug the charger and disconnect the healthy battery from the over discharged battery. Then reconnect the charger to the discharged battery and finish the charge.

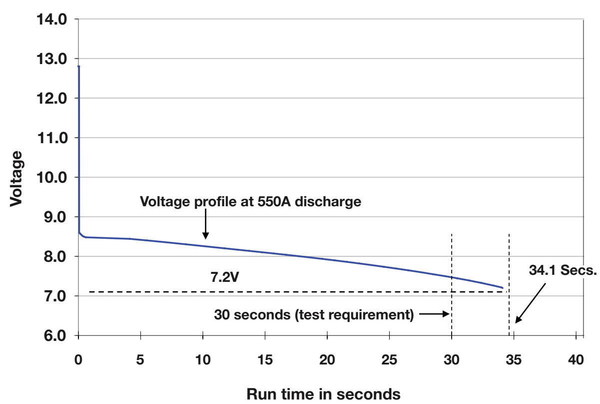
Procedure #2

1. Bring the battery to room temperature—25°C (77°F)—if it is not already there.
2. Measure the open circuit voltage (OCV). Continue to step 3 if it measures at least 6.00V.
3. Charge the battery for 24 hours using a constant current charge that is 5% of the 20-hour capacity of the battery (5A for a 100Ah battery). The charger should be able to provide a driving voltage as high as 18.00V. Monitor the battery temperature; *discontinue charging if the battery temperature rises by more than 20°C.*
4. Allow the battery to stand for 18 hours after completion of step 3.
5. Perform a capacity test on the battery and record the amp-hours delivered. The longer the discharge the more reliable the result. This is Cycle 1.
6. Repeat steps 3 through 5. The capacity noted in step 5 is the Cycle 2 capacity. Proceed to step 7 only if Cycle 2 capacity is greater than Cycle 1 capacity; otherwise replace the battery.
7. Repeat steps 3 through 5 to get Cycle 3 capacity and proceed to step 8 only if Cycle 3 capacity is equal to or more than the capacity in Cycle 2. Replace the battery if Cycle 3 capacity is less than Cycle 2 capacity. If the capacity is greater than or equal to 80% of the rated capacity of the battery it may be returned to service.
8. Recharge the battery and put back in service if Cycle 3 capacity is equal to or exceeds Cycle 2 capacity.

Extreme cold temperature performance

High discharge rate performance in extremely cold conditions is another area in which ODYSSEY® batteries excel. An example of this is shown in Figure 5. Even at -40°C (-40°F) the battery was able to support a 550A load for over 30 seconds before its terminal voltage dropped to 7.2V.

Figure 5: CCA test @ -40°C (-40°F) on 31-PC2150



Since all ODYSSEY batteries are designed similarly, one can expect similar outstanding cold temperature performance from any of the other ODYSSEY batteries.

PARASITIC LOADS

With the proliferation of more and more electronic equipment in cars, trucks, motorcycles and powersports equipment, the phenomenon of parasitic loads is becoming a serious problem.

Parasitic loads are small currents, typically of the order of a few milliamps (mA) that the battery has to deliver continuously. Retaining memories and operating security systems are common examples of parasitic drains on batteries in modern systems.

On the surface it would seem that such small loads would not be a factor in the overall scheme of things. However, since parasitic loads can be applied on a long-term basis (weeks or months is not uncommon), the cumulative amp-hours (Ah) extracted from the battery can be significant. For example, a 10mA draw on a motorcycle battery will discharge it by 0.24Ah per day. If left unchecked for 30 days, that small 10mA parasitic load will discharge a 20Ah battery by 7.2Ah – a 36% depth of discharge (DOD).

For reliable engine cranking, an ODYSSEY battery needs to have at least 70% of its capacity available. In other words, no more than 30% of the battery's capacity can be discharged for good starting performance. Thus battery capacity and magnitude of the parasitic drain are needed to estimate the maximum number of days the load can be tolerated before the battery's cranking performance is potentially compromised.

To see how this works, consider the ODYSSEY 31-PC2150 battery, which is a 92Ah BCI Group 31 size battery. Based on the percent discharge criteria given in the previous paragraph, to ensure reliable engine cranking no more than 28 amp-hours (30% of 92Ah) should be lost due to parasitic drain. If the vehicle has a 100mA or 0.1A draw, then the maximum number of hours the battery should be allowed to discharge is 280 hours (28/0.10) or about 12 days.

The following steps summarize how to estimate the maximum time your ODYSSEY battery can support a parasitic draw before its engine starting capability is compromised.

1. Determine the parasitic draw in amps; if you have that number in milliamps, divide it by 1000 to convert it to amps and denote this as A_{par}.
2. Look up battery specification table to see your battery's amp-hour capacity at the 10-hour rate of discharge (C10) and multiply that by 0.30. This gives the maximum capacity you can take out of the battery to support the parasitic drain and call this P_{cap} to denote parasitic drain capacity in amp-hours.
3. Divide P_{cap} by A_{par} (P_{cap}/A_{par}) to get the maximum hours the battery should be drained by the parasitic draw, then divide that number by 24 to get the maximum number of days the battery should be allowed to discharge and still be able to reliably start.

Regardless of the application, it is important to make sure your battery does not have a parasitic load; if there is a slow drain, connect the battery to a float (trickle) charger that puts out between 13.5V and 13.8V at the battery terminals. Physically disconnecting one of the battery cables is an alternate method to eliminate the drain.

SHOCK, IMPACT AND VIBRATION TESTING

(A) Caterpillar™ 100-hour vibration test

In this test, a fully charged battery was vibrated at 34±1 Hz and 1.9 mm (0.075") total amplitude in a vertical direction, corresponding to an acceleration of 4.4g. The test was conducted for a total of 100 hours. The battery is considered to have passed the test if (a) it does not lose any electrolyte, (b) it is able to support a load test and (c) it does not leak when subjected to a pressure test.

The ODYSSEY battery successfully completed this arduous test.

(B) Shock and vibration test per IEC 61373, Sections 8-10

An independent test laboratory tested an ODYSSEY PC2150 battery for compliance to IEC standard 61373, Category 1, Class B, and Sections 8 through 10. Section 8 calls for a functional random vibration test, Section 9 requires a long-life random vibration test and Section 10 is for a shock test. Table 2, on the next page summarizes the test results.

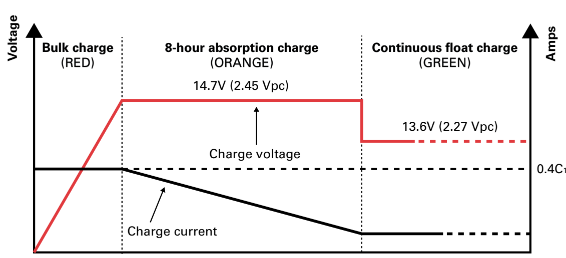
Table 2: Shock and vibration test results per IEC 61373

Test	Standard	Requirement	Result
Functional random vibration	IEC 61373, Section 8, Category 1, Class B	5-150Hz, 0.1g_{rms} vertical, 0.071g_{rms} longitudinal, 0.046g_{rms} transverse; 10 minutes in each axis	Compliant
Long-life random vibration	IEC 61373, Section 9, Category 1, Class B	5-150Hz, 0.8g_{rms} vertical, 0.56g_{rms} longitudinal, 0.36g_{rms} transverse; 5 hours in each axis	Compliant
Shock	IEC 61373, Section 10, Category 1, Class B	30msec. pulses in each axis (3 positive, 3 negative); 3.06g_{peak} vertical, 5.1g_{peak} longitudinal, 3.06g_{peak} transverse	Compliant

CHARGING ODYSSEY® BATTERIES

Charging is a key factor in the proper use of a rechargeable battery. Inadequate or improper charging is a common cause of premature failure of rechargeable lead acid batteries. To properly charge your premium ODYSSEY® battery, EnerSys has developed a special charge algorithm. It is designed to rapidly and safely charge these batteries. Called the IUU profile (a constant current mode followed by two stages of constant voltage charge), Figure 6 shows it in a graphical format. No manual intervention is necessary with chargers having this profile.

Figure 6: Recommended three-step charge profile



NOTES:
1. Charger LED stays RED in bulk charge phase (DO NOT TAKE BATTERY OFF CHARGE)
2. LED changes to ORANGE in absorption charge phase (BATTERY AT 80% STATE OF CHARGE)
3. LED changes to GREEN in float charge phase (BATTERY FULLY CHARGED)
4. Charge voltage is temperature compensated at ±24mV per battery per °C variation from 25°C

If the charger has a timer, then it can switch from absorption mode to float mode when the current drops to 0.001C_{10} amps. If the current fails to drop to 0.001C_{10} amps, then the timer will force the transition to a float charge after no more than 8 hours. As an example, for a PC1200 battery, the threshold current should be 44mA. Another option is to let the battery stay in the absorption phase (14.7V or 2.45 VPC) for a fixed time, such as 6-8 hours, then switch to the continuous float charge. Table 3 shows three charger design variations, all based on the basic three-step profile shown in Figure 6.

Table 3: Three-step charger design options

	Charge Phase & Feature				
	Bulk charge	Absorption charge	Timer	Trigger current, A	Float charge
Design 1	Yes	Yes	Yes	0.001C_{10}	Yes
Design 2	Yes	Yes	Yes	No trigger	Yes
Design 3	Yes	Yes	No	0.10C_{10}	Yes

In Design 1, the charger has a timer and a current threshold that triggers the switch from absorption charge to float charge. Because the charger has a timer override, the charge current is set at a low value. If the charge current does not drop to 0.001C_{10} amps within 8 hours on absorption charge, then the timer will force the charger to switch to a temperature-compensated float charge.

The charger does not have a current trigger in Design 2. Rather, the timer forces the charger to stay in the absorption phase for a fixed time (8 hours) before allowing it to switch down to a temperature-compensated float charge.

Because the charger in Design 3 does not have a timer, the threshold current to trigger the switch from the absorption phase to the temperature-compensated float charge phase is kept relatively high. Note that in this design the battery will not be fully charged when the charger switches to the float charge phase. *A minimum of 16-24 hours on float will be required to complete the charge.*

Table 4 shows the minimum charge currents for the full range of ODYSSEY batteries when they are used in deep cycling application. When using a charger with the IUU profile, we suggest the following ratings for your ODYSSEY battery. *Note the charger current in the bulk charge mode must be 0.4C_{10} or more.* A list of chargers approved by EnerSys for use with ODYSSEY batteries is available at **www.odysseybattery.com** under FAQs.

Table 4: Battery size and minimum three-step charger current

Charger rating, amps	Recommended ODYSSEY® Battery Model
6A	PC310 / PC535 / PC545 / PC625 / PC680
10A	PC925 or smaller battery
15A	PC1200 or smaller battery
25A	PC1500 or smaller battery
25A	PC1700 or smaller battery
40A	PC2150 or smaller battery
50A	PC2250 or smaller battery

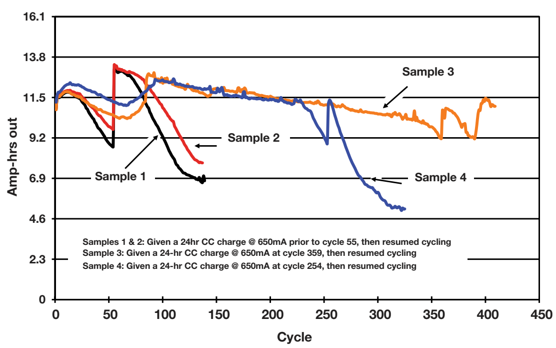
Small, portable automotive and powersport chargers may also be used to charge your ODYSSEY battery. These chargers are generally designed to bring a discharged battery to a state of charge (SOC) that is high enough to crank an engine. Once the engine is successfully cranked, its alternator should fully charge the battery. It is important to keep in mind the design limitations of these small chargers when using them.

Another class of chargers is designed specifically to maintain a battery in a high SOC. These chargers, normally in the 3/4 amp to 1 1/2 amp range, are not big enough to charge a deeply discharged ODYSSEY® battery. They must only be used either to continuously compensate for parasitic losses or to maintain a trickle charge on a stored battery, as long as the correct voltages are applied. It is very important, therefore, to ensure that the ODYSSEY battery is fully charged before this type of charger is connected to it.

Effect of undercharge in cycling applications

Proper and adequate charging is necessary to ensure that ODYSSEY batteries deliver their full design life. Generally speaking, a full recharge requires about 5% more amp-hours (Ah) must be put back in than was taken out. In other words, for each amp-hour extracted from the battery, about 1.05Ah must be put back to complete the recharge.

Cycling tests conducted on an ODYSSEY PC545 battery demonstrated the impact raising the charge voltage from 14.2V to 14.7V has on the cycle life of the battery. The results are shown in the graph below.



Samples 1 and 2 were charged at 14.2V while Samples 3 and 4 were charged at 14.7V. All batteries were discharged at 2.3A until the terminal voltage dropped to 10.02V and charged for 16 hours. In this particular test, a capacity of 11.5Ah corresponds to 100% capacity and 9.2Ah is 80% of rated capacity and the battery is considered to have reached end of life at that point.

The message to be taken from this graph is clear – in deep cycling applications it is important to have the charge voltage set at 14.4 – 15.0V. A nominal setting of 14.7V is a good choice, as shown by the test results.

(A) Selecting the right charger for your battery

Qualifying portable automotive and powersport chargers for your ODYSSEY battery is a simple two-step process.

Step 1 Charger output voltage

Determining the charger output voltage is the most important step in the charger qualification process.
If the voltage output from the charger is less than 14.2V or more than 15V for a 12V battery, then do not use the charger. For 24V battery systems, the charger output voltage should be between 28.4V and 30V. If the charger output voltage falls within these voltage limits when the battery approaches a fully charged state, proceed to Step 2, otherwise pick another charger.

Step 2 Charger type - automatic or manual

The two broad types of small, portable chargers available today are classified as either automatic or manual. Automatic chargers can be further classified as those that charge the battery up to a certain voltage and then shut off and those that charge the battery up to a certain voltage and then switch to a lower float (trickle) voltage.

An example of the first type of automatic charger is one that charges a battery up to 14.7V, then immediately shuts off. An example of the second type of automatic charger would bring the battery up to 14.7V, then switches to a float (trickle) voltage of 13.6V; it will stay at that level indefinitely. The second type of automatic charger is preferred, because the first type of charger will undercharge the battery.

A manual charger typically puts out either a single voltage or single current level continuously and must be switched off manually to prevent battery overcharge. *Should you choose to use a manual charger with your ODYSSEY battery, do not exceed charge times suggested in Table 5 below. It is extremely important to ensure the charge voltage does not exceed 15V*.

(B) Selecting battery type on your charger

Although it is not possible to cover every type of battery charger available today, this section gives the ODYSSEY battery user some general charger usage guidelines to follow, *after the charger has been qualified for use with this battery.*

In general, do not use either the gel cell or maintenance free setting, if provided on your charger. Choose the deep cycle or AGM option, should there be one on your charger. Table 5 below gives suggested charge times based on charger currents. *To achieve maximum life from your ODYSSEY battery after completing the charge time in Table 5, we recommend that you switch your charger to the 2A trickle charge position and leave the battery connected to the charger for an additional 6-8 hours. The trickle charge voltage should be 13.5V to 13.8V.*

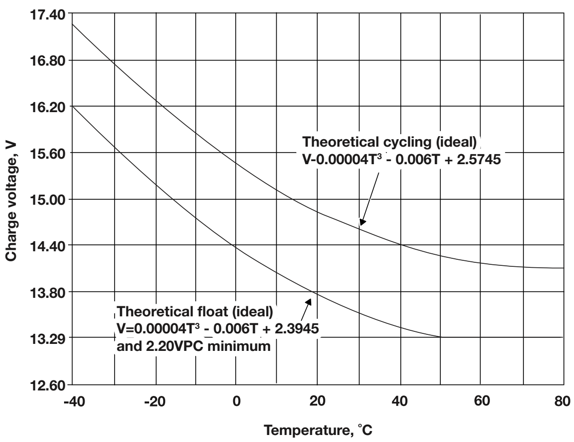
Table 5: Suggested charge times

ODYSSEY®	Charge time for 100% discharged battery	
Battery Model	10-amp charger	20-amp charger
PC310	1.28 hours	40 minutes
PC535	2.25 hours	1.25 hours
PC545	2 hours	1 hour
PC625	3 hours	1.5 hours
PC680	2.7 hours	1.5 hours
PC925	4.5 hours	2.25 hours
PC1200	6.75 hours	3.5 hours
75-PC1230 & 75/86-PC1230	9 hours	4.5 hours
25-PC1400 & 35-PC1400	10.5 hours	5.25 hours
34-PC1500, 34R-PC1500, 34M-PC1500, 34/78-PC1500 & 78-PC1500	11 hours	5.5 hours
PC1700	11 hours	5.5 hours
PC1220 & 65-PC1750	11 hours	5.5 hours
PC1800-FT	Not Recommended	17 hours
PC1350, 31-PC2150 & 31M-PC2150	16 hours	8 hours
PC2250	20 hours	10 hours

The charge times recommended in Table 5 assume that the ODYSSEY battery is fully discharged and these charge times will only achieve about a 80% state of charge. For partially discharged batteries, the charge times should be appropriately reduced. The graph in Figure 2, showing OCV and SOC, must be used to determine the battery's SOC. The battery should be trickle charged (2A setting) after high rate charging, regardless of its initial SOC.

Temperature compensation

Proper charging of all valve regulated lead acid (VRLA) batteries requires temperature compensation of the charge voltage – the higher the ambient temperature the lower the charge voltage. This is particularly true in float applications in which the batteries can stay on trickle charge for weeks or months at a time.



The temperature compensation graphs for ODYSSEY® batteries in float and cyclic applications is shown for ambient (battery) temperatures ranging from -40°C (°F) to 80°C (176°F). The compensation coefficient is approximately +/-24mV per 12V battery per °C variation from 25°C (77°F). Since the charge voltage and ambient (battery) temperature are inversely related, the voltage must be reduced as the temperature rises; conversely, the charge voltage must be increased when the temperature drops.

Note, however, that the charge voltage should not be dropped below 13.2V as that will cause the battery grids to corrode faster, thereby shortening the battery life.

RAPID CHARGING OF ODYSSEY® BATTERIES

All ODYSSEY batteries can be quickly charged. The graph below shows their exceptional fast charge characteristics at a constant 14.7V for three levels of inrush current. These current levels are similar to the output currents of modern automotive alternators. Table 6 and Figure 7 show the capacity returned as a function of the magnitude of the inrush[3] current.

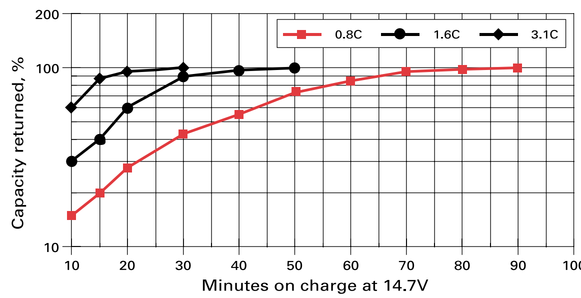
Standard internal combustion engine alternators with an output voltage of 14.2V can also charge these batteries. The inrush current does not need to be limited under constant voltage charge. However, because the typical alternator voltage is only 14.2V instead of 14.7V, the charge times will be longer than those shown in Table 5.

Table 6: Fast charge capability

Capacity returned	Inrush current magnitude		
	$0.8C_{10}$	$1.6C_{10}$	$3.1C_{10}$
60%	44 min.	20 min.	10 min.
80%	57 min.	28 min.	14 min.
100%	90 min.	50 min.	30 min.

Table 6 shows that with a $0.8C_{10}$ inrush current, a 100% discharged battery can have 80% of its capacity returned in 57 minutes; doubling the inrush to $1.6C_{10}$ cuts the time taken to reach 80% capacity to only 28 minutes.

Figure 7: Quick charging ODYSSEY® batteries



LOAD TEST PROCEDURE

This procedure should help determine whether the battery returned by the customer has reached its end of life or simply needs a full recharge. Depending on the time available one may choose to perform either the longer load test (Step 4) or the shorter ½CCA load test (Step 5).

The ½CCA test is quicker but less reliable than the longer test. This is also the test that is performed when a battery is taken to an auto store for testing.

An alternative approach to determine the health of the battery is to use the ODYSSEY® battery PortAlyzer™ handheld tester, specifically developed for these batteries. The test procedure is shown in the flowchart in the section that discusses the tester.

1. Measure the open circuit voltage (OCV) of the battery. Proceed to Step 4 or Step 5 if the OCV is equal to or more than 12.80V; if not go to Step 2.
2. Charge the battery using the ODYSSEY OMAX-50A-1B Ultimizer™ charger until the green LED light comes on, indicating the completion of the charge. Stop the test if the red LED comes on indicating a bad battery.
3. Unplug the charger and disconnect the battery from the charger. Let the battery rest of at least 10-12 hours and measure the OCV. If it is equal to or more than 12.80V proceed to the next step; otherwise reject the battery.

[3] *Inrush is defined in terms of the rated capacity (C_{10}) of the battery. A $0.8C_{10}$ inrush on a 100Ah battery is 80A.*

4. Long Test: Discharge the battery using a resistor or other suitable load until the voltage drops to 10.00V and record the time taken to reach this voltage. Let the battery rest for an hour and repeat Steps 1 through 4. If the time taken by the battery to drop to 10.00V is longer in the second discharge than in the first discharge, the battery may be returned to service after a full recharge; if not the battery should be rejected as having reached end of life.
5. ½CCA Test: Battery OCV must be at least 12.60V to proceed with this test. Connect the load tester cables and the voltage leads of a separate digital voltmeter (if the tester does not have a built-in digital voltmeter) to the battery terminals.
6. Adjust the tester load current to lad the battery to half its rated CCA and apply the load for 15 seconds. Table 7 shows the ½CCA values for all ODYSSEY® battery models. Use Table 8 to adjust the battery end of test voltage temperature.

Table 7

ODYSSEY® Battery Model	½CCA Test Value (A)	ODYSSEY® Battery Model	½CCA Test Value (A)	ODYSSEY® Battery Model	½CCA Test Value (A)
PC310	155	PC1200	275	PC1700	438
PC535	100	PC1220	340	PC1750	465
PC545	93	PC1230	365	PC1800	650
PC625	133	PC1350	480	PC2150	575
PC680	110	PC1400	410	PC2250	613
PC925	190	PC1500	440		

Table 8

Temperature	End of Test Voltage
70°F	9.60V
60°F	9.50V
50°F	9.40V
40°F	9.30V
30°F	9.10V
20°F	8.90V
10°F	8.70V
0°F	8.50V

7. At the end of 15 seconds note the battery voltage on the voltmeter and discontinue the test. If the temperature is 70°F or warmer the battery voltage should be at or above 9.60V. If so the battery can be returned to service; if below 9.60V the battery should be rejected.

ODYSSEY® BATTERIES IN NO-IDLE APPLICATIONS

Since these batteries are dual purpose in nature they can be used for both engine starting and deep cycling applications. This makes them particularly well suited for fleets such as police vehicles that would like to power their computers and communications equipment without having to idle their engines. Auxiliary power units (APU) on trucks provide another example of a no-idling application. All of these require energy sources to power loads such as computers and refrigerators with the engines shut off to reduce their carbon footprints and lower gas consumption.

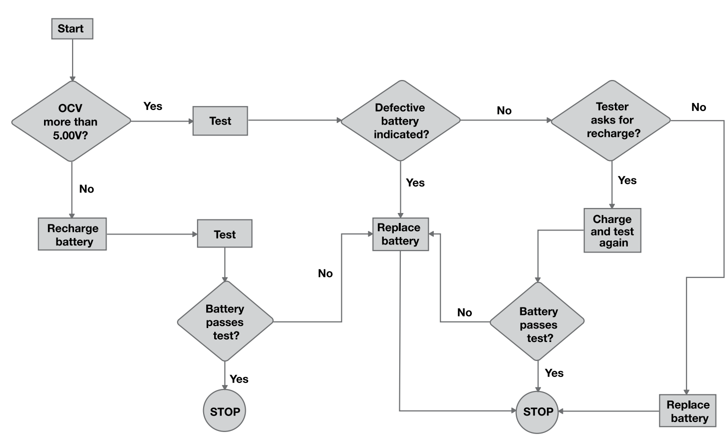
As discussed in a previous section, properly charged ODYSSEY batteries are capable of delivering as many as 400 cycles to an 80% depth of discharge (DOD) at the 5-hour rate of discharge. A shallower discharge will yield higher cycles, as noted in the cycle life vs. DOD graph shown earlier. This is the reason why ODYSSEY batteries are becoming increasingly popular in APU and police fleet applications that require batteries to have both high cycling and excellent engine cranking capabilities in the same package.

ODYSSEY® PORTALYZER™ TESTER

The ODYSSEY battery PortAlyzer™ Tester (PAT) is designed to quickly assess the condition of ODYSSEY batteries without applying a heavy load on them. It is portable and shows test results in a matter of a few seconds.

The tester applies a series of micro loads and determines the condition of the battery based on how its voltage rebounds – the weaker the battery the more sluggish the voltage rise when the load is removed. The test procedure using a PAT is shown in the flowchart below.

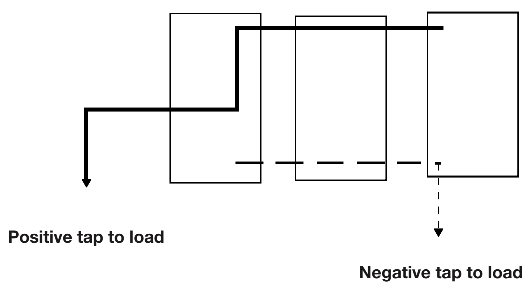
Although the tester displays a cold cranking amp (CCA) rating for the tested battery, it should be treated with circumspection as the value is calculated using a mathematical relationship and not based on a load test. A true CCA test involves a 30-second load applied to the battery at 0°F (-18°C), so a result based on a mathematical formula is inherently not very accurate.

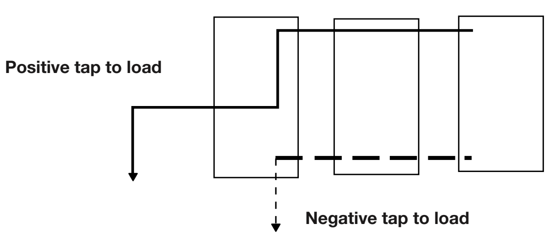


Testing ODYSSEY® batteries with the PortAlyzer™ tester

PARALLEL CONNECTIONS

It is common to have batteries connected in parallel to achieve a desired amp-hour capacity. This is done by connecting all the positives to each other and all the negatives to each other.





Typically the positive and negative leads to the load are taken from the same battery; usually the leads from the first battery are used. This is not a good practice. Instead, a better technique to connect the load is to take the positive lead from one end of the pack (the first or last battery) and the negative lead from the other end of the pack. The two methods are illustrated above. Solid lines and arrows indicate positive terminals and leads; broken lines and arrows indicate negative terminals and leads.

In both illustrations, the positive leads are connected to each other; similarly the negative leads are connected to each other. The only difference is that in the first illustration the positive and negative leads to the load come from the first and last batteries. In the second case, both leads to the load are tapped from the same battery.

The first schematic is recommended whenever batteries are hooked up in parallel to increase battery capacity. With this wiring, all batteries are forced to share both charge and discharge currents. In contrast, a closer inspection of the second schematic shows that it is possible for only the battery whose terminals are tapped to support the load. Implementing the first schematic eliminates this possibility and is therefore a better one.

VENTILATION

Valve regulated lead acid (VRLA) batteries like the ODYSSEY® battery depend on the internal recombination of the gases for proper operation. This is also why these batteries do not require periodic addition of water.

The high recombination efficiency of ODYSSEY batteries make them safe for installation in human environments. It is not uncommon to see these batteries in aircraft, hospital operating rooms and computer rooms. The only requirement is that these batteries must not be installed in a sealed or gastight enclosure.

CONCLUDING REMARKS

We believe that there is no other sealed-lead acid battery currently available commercially that can match the ODYSSEY battery for sheer performance and reliability. We hope that the preceding material will help the reader arrive at the same conclusion.

FREQUENTLY ASKED SLI BATTERY QUESTIONS

What is the CCA rating?

The cold cranking ampere (CCA) rating refers to the number of amperes a battery can deliver for 30 seconds at a temperature of -18°C (0°F) before the voltage drops to 1.20 volts per cell, or 7.20 volts for a 12V battery. A 12V battery that has a rating of 550 CCA means that the battery will provide 550 amps for 30 seconds at -18°C (0°F) before the voltage falls to 7.20V.

What is the MCA rating?

The marine cranking ampere (MCA) rating refers to the number of amperes a battery can deliver for 30 seconds at a temperature of 0°C (32°F) until the battery voltage drops to 7.20 volts for a 12V battery. A 12V battery that has a MCA rating of 725 MCA means that the battery will give 725 amperes for 30 seconds at 0°C (32°F) before the voltage falls to 7.20V.

The MCA is sometimes called the cranking amperes or CA.

What is a HCA rating?

The abbreviation HCA stands for hot cranking amps. It is the same as MCA, CA or CCA, except that the temperature at which the test is conducted is 26.7°C (80°F).

What is the PHCA rating?

Unlike CCA and MCA the pulse hot cranking amp (PHCA) rating does not have an "official" definition; however, we believe that for true SLI purposes, a 30-second discharge is unrealistic. The PHCA, a short duration (about 3-5 seconds) high rate discharge, is more realistic. Because the discharge is for such a short time, it is more like a pulse.

Are these gel cells?

No, the ODYSSEY® battery is NOT a gel cell. It is an absorbed electrolyte type battery, meaning there is no free acid inside the battery; all the acid is kept absorbed in the glass mat separators. These separators serve to keep the positive and negative plates apart.

What is the difference between gel cell and AGM?

The key difference between the gel cell and the absorbed glass mat (AGM) is that in the AGM cell all the electrolyte is in the separator, whereas in the gel cell the acid is in the cells in a gel form. If the ODYSSEY battery were to split open, there would be no acid spillage! That is why we call the ODYSSEY battery a Drycell battery.

What is the Ah rating?

The ampere-hour (Ah) rating defines the capacity of a battery. A battery rated at 100Ah at the 10-hour rate of discharge will deliver 10A for 10 hours before the terminal voltage drops to a standard value such as 10.02 volts for a 12V battery. The PC1200 battery, rated at 40Ah will deliver 4A for 10 hours.

What is reserve capacity rating?

The reserve capacity of a battery is the number of minutes it can support a 25-ampere load at 27°C (80°F) before its voltage drops to 10.50 volts for a 12V battery. A 12V battery with a reserve capacity rating of 100 will deliver 25 amps for 100 minutes at 80°F before its voltage drops to 10.5V.

Is the ODYSSEY® battery a dry battery?

Because the ODYSSEY® battery has no free acid inside, it is exempted from the requirements of 49 CFR § 173.159 of the US Department of Transportation (USDOT). The battery also enjoys a "nonspillable" classification and falls under the International Air Transport Association (IATA) "unrestricted" air shipment category. These batteries may be shipped completely worry-free. Supporting documentation is available.

What is impedance?

The impedance of a battery is a measure of how easily it can be discharged. The lower the impedance the easier it is to discharge the battery. The impedance of the ODYSSEY battery is considerably less than that of a conventional SLI battery, so its high rate discharge capability is significantly higher than that of a conventional SLI battery.

What is the short-circuit current of these batteries?

As mentioned before, this battery has very low impedance, meaning that the short circuit current is very high. For a PC925 battery, the short circuit current can be as high as 2,500 amperes.

Do I ruin the battery if I accidentally drop it?

Not necessarily, but it is possible to damage the internal connections sufficiently to damage the battery.

Does mishandling the battery void the warranty?

Our warranty applies only to manufacturing defects and workmanship issues; the policy does not cover damages suffered due to product mishandling.

What is so special about thin plate pure lead technology? Is it a new technology?

The answer lies in the very high purity (99.99%) of our raw lead materials, making our product very special. The technology is not new; the sealed lead recombinant technology was invented and patented by us back in 1973.

Why don't you have to winterize your batteries? What's so special about them?

In general, winterizing refers to a special maintenance procedure conducted on an automotive engine to ensure its reliability during the winter season. The procedure essentially checks the engine's charging system; in addition, the battery is load tested according to a specific method defined by the Battery Council International (BCI). Although ODYSSEY batteries do not specifically require this test to be conducted on them, the final decision whether or not to conduct this test is left to the user's discretion.

Are these Ni-Cd batteries? Why doesn't somebody make these in Ni-Cd? Wouldn't they charge faster as a Ni-Cd?

No, the ODYSSEY battery is NOT a Ni-Cd battery. It is a valve regulated lead acid (VRLA) battery. In general, Ni-Cd batteries are much more expensive to manufacture and recycle, so they are less cost effective than a lead acid product.

A Ni-Cd battery would charge faster than a conventional lead acid battery; however, the ODYSSEY battery is NOT a conventional battery and its charge characteristics are somewhat similar to nickel cadmium batteries. In fact, with a powerful enough charger, it is possible to bring ODYSSEY batteries to better than 95% state of charge in less than 20 minutes! That is very comparable to the fast charge capabilities of a nickel cadmium product.

Notes

ODYSSEY®
THE EXTREME BATTERY

Notes

About EnerSys®

EnerSys® is a global leader in stored energy solutions for automotive, military, and industrial applications. With manufacturing facilities in 17 countries, sales and service locations throughout the world, and over 100 years of battery experience, EnerSys is a powerful partner for automotive service and parts providers.

EnerSys
P.O. Box 14145
Reading, PA 19612-4145, USA
Tel: +1-610-208-1991
+1-800-538-3627
Fax: +1-610-372-8613

Regional Sales

EnerSys Energy Products Inc.
617 North Ridgeview Drive
Warrensburg, MO 64093-9301, USA
Tel: +1-660-429-2165
Fax: +1-660-429-1758

EnerSys Australia Pty Ltd.
54-58 Derby Street
Silverwater, NSW 2128
Australia
Tel: + 61 (0) 2 9739 9999
Fax: + 61 (0) 2 9739 9900

www.odysseybattery.com

Power/Full Solutions

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