Battery guide

Contents

Introduction

Many people choose to use CPAP devices running on battery power in situations where mains power is not available, such as on camping holidays, or in boats and motor homes. Some people use battery power in remote areas where mains power may not be supplied, or as a backup in areas prone to power failure. The following guide will help you understand the requirements for running a flow generator or humidifier from battery power.

ResMed Ltd 1 Elizabeth Macarthur Drive Bella Vista NSW 2153 Australia Tel: +61 2 8884 1000 Fax: +61 2 8884 2000 ABN 30 003 765 142

Running a flow generator

If you wish to run a ResMed flow generator from a battery, and you intend to use the battery for a single night before recharging, the following equipment is required:

- a marine battery or deep-cycle battery rated at 50 amp-hours or higher

  and

- a modified sine wave inverter with a continuous power rating of 150 watts or higher (available at electronics stores).

  or

- one of the ResMed converters, which can be used with the S9 series, the S8 and S8 II series of products, the VPAP III ST-A, VPAP Auto, VPAP Malibu and the VPAP series (which includes VPAP Auto 25, VPAP ST, VPAP S, VPAP IV ST, VPAP IV and S8 Auto 25).

Refer to the following pages to confirm your exact battery and inverter/converter requirements.

Running a flow generator with humidifier

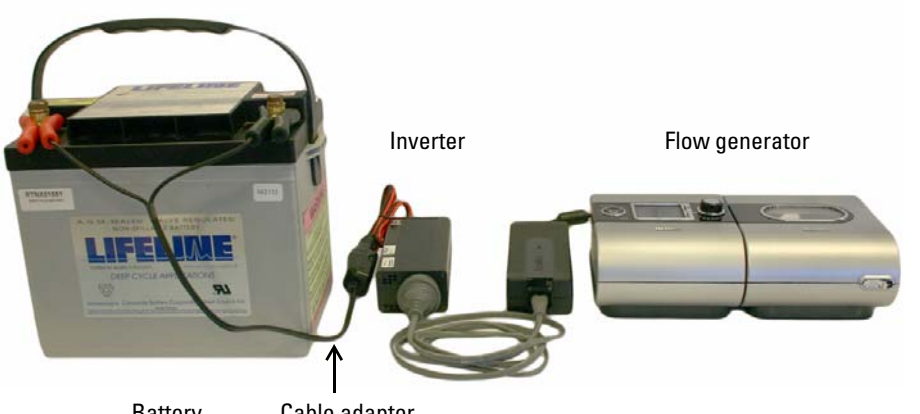
If you wish to use a battery to run a ResMed flow generator with the HumidiAire 2i, HumidAire 3i or H4i, a pure sine wave inverter with a minimum continuous power rating of 200 watts or higher is required.

The S9 with H5i will operate with a modified sine wave inverter. A minimum continuous power rating of 150 watts or higher is required. Refer to the following pages to confirm your exact battery and inverter requirements.

Warning

Other ResMed heated humidifiers must not be used with inverters. Damage to the unit or serious injury to the user may result. If you are using another brand of heated humidifier, check with the manufacturer for their recommendation.

It is also recommended that the inverter is certified by an accredited testing and certification organisation, such as VDE, TUV or BSI in addition to CE markings for EU countries or UL markings for the USA. Please contact your local ResMed office for more information.



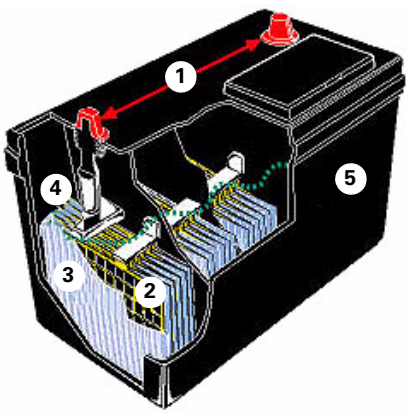
The equipment

Batteries

Battery basics

The kind of batteries typically used to run CPAPs are rechargeable lead-acid batteries. They work on a simple principle: two dissimilar metals are immersed in an electrolyte and this produces a flow of electrical current between the two metals. This is a flooded lead-acid battery. Modern rechargeable batteries usually have 6 banks of plates or cells producing 2.11 volts per cell, for a terminal voltage of 12.66 volts.

Lead-acid battery construction



1 Terminals
2 Plates
3 Electrolyte
4 Cell wall
5 Outer case

Types of batteries

Not all batteries are created equal. They are manufactured differently for different purposes.

Automotive batteries

Modern car batteries are designed to supply a surge of high current to crank the engine of a car. This is achieved by manufacturing the battery with a large number of thin plates to maximise the surface area of the plates. The plates are composed of a lead "sponge", similar in appearance to a very fine foam sponge. If subjected to deep discharge, this sponge will quickly be consumed and fall to the bottom of the cells. Automotive batteries should never be discharged by more than about 30% before recharge. A car battery will only last about 30 deep cycles, while they may last for thousands of cycles in normal starting use (2-5% discharge).
Automotive batteries are rated in Cold Cranking Amps (CCA). This is the amount of current that the battery is able to supply for 30 seconds at -20°C while maintaining a terminal voltage of 7.2 volts or more.

Deep-cycle batteries

The major difference between a true deep cycle battery and other types of batteries is that the plates are solid lead. They are manufactured with much thicker plates in each cell and can be discharged as much as 80% or more.
Deep-cycle batteries are rated in amp-hours (AH): this means the current that can be drawn from the battery for a specified time, for example, a battery rated at 50 AH is able to supply 1 amp for 50 hours, or 2 amps for

25 hours and so on. This only works up to a point, as there are constraints on the maximum performance.

Note: *There is no direct correlation between CCA and AH - one can not be calculated from the other.*

Marine batteries

Marine batteries are manufactured with thick plates in their cells to facilitate deeper discharges and are also rated in amp-hours. Most marine batteries are not true deep-cycle, but a type of hybrid. Most marine batteries may be safely discharged up to 60% before recharging.

! Caution

Check with the battery manufacturer for recommendations of discharge rate. The information supplied should be used as a guide only.

Other types of batteries

AGM, or Absorbed Glass Mat

A newer type of sealed battery uses Absorbed Glass Mats, or AGM between the plates. This is a very fine fibre boron-silicate glass mat. These batteries have all the advantages of gelled batteries (see below), but can take much more severe use. The plates in AGM batteries are tightly packed and rigidly mounted, and will withstand shock and vibration much better than any conventional battery.

AGM batteries have several advantages over both gelled and flooded batteries, at about the same cost as gelled batteries:

- Since all the electrolyte is contained in the glass mats, they cannot spill, even if broken. This also means that since they are non-hazardous, the shipping costs are lower. In addition, since there is no liquid to freeze and expand, they are practically immune to freezing damage.
- The charging voltages are the same as for any standard battery - there is no need for any special adjustments or problems with incompatible chargers.
- AGM batteries have a very low self-discharge - from 1% to 3% per month is typical. This means that they can sit in storage for much longer periods without charging.

Gelled electrolyte

Gelled batteries, or gel cells contain acid that has been "gelled" by the addition of silica gel, turning the acid into a solid mass that looks like thick jelly. The advantage of these batteries is that it is impossible to spill acid even if the battery is broken.

A disadvantage of gel cells is that they must be charged at a lower voltage than flooded or AGM batteries. If overcharged, voids can develop in the gel which will never heal, causing a loss in battery capacity. In hot climates, water loss can be enough over 2-4 years to cause premature battery death.

Battery maintenance

Lead-acid batteries are perishable. During the discharge process, lead sulphate crystals are formed in the pores and on the surfaces of the positive and negative plates inside the battery. This creation of crystals is commonly called lead sulphation and it accounts for over 80% of deep-cycle battery failures. The longer sulphation occurs, the larger and harder the lead sulphate crystals become. The positive plates will be light brown and the negative plates will be a dull, off-white colour. These crystals lessen a battery's capacity and its ability to be recharged. Recharge as soon after discharge as possible, and if the battery is to be stored for more than two weeks, top up the charge frequently. This is the best way to prevent sulphation.

1 Add a battery conditioner in accordance with the manufacturer's instructions. This is a chemical additive which prolongs battery life.

2 Check electrolyte levels regularly and top up only with demineralised water as required.

3 Buy a hydrometer and check the specific gravity of the electrolyte in each cell of the battery. This will detect damaged or collapsed cells before they leave you stranded with a useless battery.

Storing a battery

1 If the battery has filler caps, check the electrolyte level in each cell. If required, add only demineralised water to the recommended level, but do not overfill.

2 Clean the top of the battery and the terminal posts.

3 Fully charge the battery.

4 Store it in a dry, cool place (above freezing), where it can be easily recharged.

5 Most importantly, prevent sulphation by keeping the battery charged at 100% state-of-charge level be frequent recharging. Once every two weeks is recommended.

Caution

Always check with the battery manufacturer for charging instructions. Damage to the cells or reduction in service life may result from incorrect charging.

Connecting a converter/ inverter to a battery

Most converters and inverters come with a car cigarette lighter plug fitted to provide a connection to the car battery. They can be connected to an auxiliary battery via the cigarette lighter outlet of a car or 4WD vehicle. If you need to connect directly to the battery terminals (such as if you carry the battery away from the vehicle), you will need an adapter cable. Refer to the photograph below.
This cable provides a more energy-efficient connection than using the car cigarette lighter socket, because it by-passes the car electrical system.

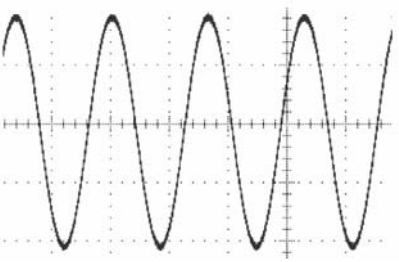
Warning

Do not attempt to start the vehicle engine while using the CPAP/VPAP unit powered from the vehicle battery as dangerous voltage spikes are produced that can damage the unit.

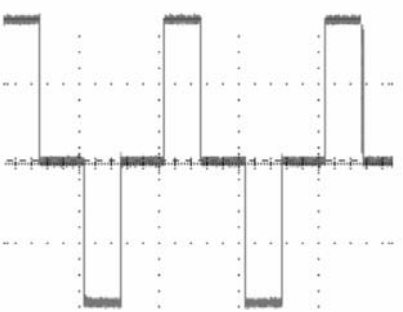
Inverters

There are several different types of inverters available. The most common types are pure sine wave or modified sine wave. A pure sine wave inverter produces an output waveform that is the same as a domestic power outlet. They are more difficult to manufacture and are the most expensive type. The outputs of the two different types look like this:

Pure sine wave



Modified sine wave



Power ratings

In addition to the output waveform, inverters also carry a power rating. This indicates the amount of power the inverter is capable of delivering. Most inverters will have a continuous rating and a surge or peak rating. The continuous rating indicates the power level it is capable of delivering under sustained use without overload. The surge or peak rating refers to a level that can be delivered for short periods. How long the inverter is capable of delivering its surge rated power output for will vary from one manufacturer to another.

Warning

It is also recommended that the inverter is certified by an accredited testing and certification organisation, such as VDE, TSU or BSI in addition to CE markings for EU countries or UL markings for the USA. Please contact your local ResMed office for more information.

Minimum inverter requirements

The following table is a guide to the minimum inverter requirements for each product. Power ratings quoted are continuous ratings:

Inverter type	**Products**		
Modified sine wave - 150 watt	• AutoSet CS™ 2/ VPAP™ Adapt SV	• C-Series Tango™	• S6™ series
	• S7 series	• S8™ series	• S8™ II series
	• S9™ series	• S9 series + H5i	• VPAP™ III series
	• VPAP™ series	• VPAP™ Auto	• VPAP™ Malibu
Inverter type	**Products with humidifier (HumidAire 2i™, HumidAire 3i™, H4i™, C-Series heated humidifier)** **Note: HumidAire™ must not be used with inverters!**		
Pure sine wave - 300 watt continuous Peak/Surge rating - 500 watt	• AutoSet CS™ 2/ VPAP™ Adapt SV	• C-Series Tango™	• S7 series
	• S8™ series	• S8™ II series	• VPAP™ III series
	• VPAP™ series	• VPAP™ Auto	• VPAP™ Malibu

Note: *The VPAP series inverters are to be used in conjunction with the Battery Adapter Cable (p/n 22006)*

Caution

The C-Series Tango with C-Series heated humidifier is 110V only.

Warning

Other ResMed heated humidifiers must not be used with inverters. Damage to the unit or serious injury to the user may result. If you are using another brand of heated humidifier, check with the manufacturer for their recommendation.

Converters

ResMed supplies the following converters for the following products:

Product	Converter
S8 & S8 II series, VPAP Auto	DC-12 converter (p/n 33942)
VPAP III ST-A	DC 24/30 converter (p/n 22015)
VPAP series	DC-24 converter (p/n 26932) to be used in conjunction with the Battery Adapter Cable (p/n 22006)

Note: *ResMed no longer distributes converters for the AutoSet CS2 or VPAP Adapt SV.*

Why use a converter?

- The converter is more efficient than an inverter.
- The converter provides electrical protection to the CPAP device in the event that the adapter leads are connected incorrectly to the battery.
- The converter provides regulation of the battery voltage: a fully charged battery has a terminal voltage of 13.5 volts and will reduce as the battery is discharged.
- The converter will shutdown automatically when the voltage drops below 10.5 volts for a 12 volt battery, or 21 volts for a 24 volt battery. This will protect the battery from damage due to being allowed to fully discharge.
- The converter provides electrical isolation to the CPAP device

Battery size tables

CPAP and auto CPAP powered with inverter

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S6 CPAP • S7 Lightweight	6	1.24	15
	8	1.42	17
	10	1.52	18
	12	1.65	20
	16	1.95	23
	20	2.22	27
• C-Series Tango	6	0.63	8
	8	0.73	9
	10	0.84	10
	12	0.94	11
	16	1.16	14
	20	1.39	17
• C-Series Tango + C-Series heated humidifier (set to 4)	6	2.73	33
	8	2.91	35
	10	3.11	37
	12	3.24	39
	16	3.54	43
	20	3.91	47
• S7 Elite • AutoSet Spirit • AutoSet Respond	6	1.39	16
	8	1.48	18
	10	1.61	19
	12	1.69	20
	16	1.96	23
	20	2.28	27
• AutoSet Spirit + HumidAire 2i • AutoSet Respond + HumidAire 2i • S7 Elite + HumidAire 2i • S7 Lightweight + HumidAire 2i	6	3.56	43
	8	3.68	44
	10	3.80	46
	12	3.93	47
	16	4.25	51
	20	4.52	54

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S8 Lightweight • S8 Escape	6	1.02	12
	8	1.12	13
	10	1.24	15
	12	1.36	16
	16	1.62	19
	20	1.90	23
• S8 Lightweight + HumidAire 3i • S8 Escape + HumidAire 3i	6	3.75	45
	8	3.84	46
	10	3.96	48
	12	4.09	49
	16	4.34	52
	20	4.63	56
• S8 Elite • S8 AutoScore • S8 AutoSet Vantage • S8 AutoSet Spirit • S8 AutoSet C • S8 Respond (product code 33127)	6	1.13	14
	8	1.27	15
	10	1.40	17
	12	1.52	18
	16	1.81	22
	20	2.12	25
• S8 Elite + HumidAire 3i • S8 AutoScore + HumidAire 3i • S8 AutoSet Vantage + HumidAire 3i • S8 AutoSet Spirit + HumidAire 3i • S8 AutoSet C + HumidAire 3i • S8 Respond (product code 33127) + HumidAire 3i	6	3.86	46
	8	4.00	48
	10	4.12	50
	12	4.25	51
	16	4.54	54
	20	4.85	58
• S8 Escape II (EPR-setting 3)	5	0.41	5
	10	0.61	8
	15	0.86	11
	20	1.17	14
• S8 Escape II (EPR-setting 3, full time) + H3i (set to 4)	5	4.99	60
	10	4.91	59
	15	5.93	71
	20	6.08	73

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S8 Escape II (EPR-setting 3, full time) + H4i (set to 4)	5	8.49	102
	10	9.6	115
	15	9.38	113
	20	11.26	135
• S8 Elite II • S8 AutoScore II • S8 AutoSet Spirit II • S8 AutoSet • S8 Respond (product code 33137)	6	0.91	11
	8	0.94	11
	10	1.09	13
	12	1.20	14
	16	1.48	18
	20	1.76	21
• S8 Elite II + HumidAire 3i • S8 AutoScore II + HumidAire 3i • S8 AutoSet Spirit II + HumidAire 3i • S8 AutoSet + HumidAire 3i • S8 Respond (product code 33137) + HumidAire 3i	6	3.46	41
	8	3.36	40
	10	3.66	44
	12	3.84	46
	16	3.77	45
	20	4.51	54
• S9 Elite (EPR Setting 0) • S9 AutoSet (EPR Setting 0)	6	0.89	11
	8	0.95	12
	10	1.02	12
	12	1.08	13
	16	1.23	15
	20	1.41	17
• S9 Elite (EPR Setting 3) • S9 AutoSet (EPR Setting 3)	6	0.83	10
	8	0.89	11
	10	0.91	11
	12	0.98	12
	16	1.14	14
	20	1.32	16
• S9 Elite + H5i (EPR Setting 0, H5i setting 3) • S9 AutoSet + H5i (EPR Setting 0, H5i setting 3)	6	2.57	31
	8	2.76	33
	10	3.01	36
	12	3.32	40
	16	3.77	45
	20	4.10	49

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S9 Elite + H5i (EPR Setting 3, H5i setting 3) • S9 AutoSet + H5i (EPR Setting 3, H5i setting 3)	6	2.72	33
	8	2.99	36
	10	2.89	35
	12	3.26	39
	16	3.61	43
	20	3.64	44
• S9 Elite + H5i (EPR Setting 0, H5i setting 6) • S9 AutoSet + H5i (EPR Setting 0, H5i setting 6)	6	4.94	59
	8	5.45	65
	10	5.90	71
	12	6.18	74
	16	6.47	78
	20	6.69	80
• S9 Elite + H5i (EPR Setting 3, H5i setting 6) • S9 AutoSet + H5i (EPR Setting 3, H5i setting 6)	6	4.59	55
	8	5.09	61
	10	5.43	65
	12	6.09	73
	16	6.30	76
	20	6.58	79
• S9 Elite + H5i + Climate control (EPR Setting 0, CC setting 27° C) • S9 AutoSet + H5i + Climate control (EPR Setting 0, CC setting 27° C)	6	3.05	37
	8	3.69	44
	10	4.12	49
	12	4.48	54
	16	6.06	73
	20	7.25	87
• S9 Elite + H5i + Climate control (EPR Setting 3, CC setting 27° C) • S9 AutoSet + H5i + Climate control (EPR Setting 3, CC setting 27° C)	6	2.52	30
	8	2.98	36
	10	3.69	44
	12	4.09	49
	16	5.09	61
	20	6.48	78

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S9 Elite + H5i + Climate control (EPR Setting 0, CC setting 30° C) • S9 AutoSet + H5i + Climate control (EPR Setting 0, CC setting 30° C)	6	3.32	40
	8	3.78	45
	10	4.20	50
	12	4.71	57
	16	5.68	68
	20	6.49	78
• S9 Elite + H5i + Climate control (EPR Setting 3, CC setting 30° C) • S9 AutoSet + H5i + Climate control (EPR Setting 3, CC setting 30° C)	6	3.06	37
	8	3.29	39
	10	3.73	45
	12	4.26	51
	16	5.20	62
	20	6.07	73

** As treatment pressure varies widely with automatic devices, 95th percentile pressure is used for all AutoSet products.*

VPAP powered with inverter

Product	IPAP pressure (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• VPAP III • VPAP™ III ST	5	1.19	15
	10	1.42	17
	15	1.67	20
	20	1.93	23
	25	2.21	27
• VPAP III + HumidAire 2i • VPAP III ST + HumidAire 2i	5	3.57	43
	10	3.81	46
	15	4.06	49
	20	4.32	52
	25	4.59	55
• VPAP™ III ST-A • VPAP III ST-A with QuickNav	5	1.65	20
	10	1.86	22
	15	2.11	25
	20	2.41	29
	25	2.76	33
	30	3.15	38
• VPAP III ST-A + HumidAire 2i • VPAP III ST-A with QuickNav + HumidAire 2i	5	4.04	48
	10	4.25	51
	15	4.49	54
	20	4.79	58
	25	5.15	62
	30	5.54	66
• VPAP series (VPAP Auto 25, VPAP ST, VPAP S, VPAP IV ST, VPAP IV, S8 Auto 25)	10	1.4	16
	15	1.6	19
	20	1.9	22
	25	2.2	26
• VPAP series + H4i (set to 4)	10	13	156
	15	12.9	155
	20	14	168
	25	13.4	161

Note: *The values in the table are based on a respiratory rate of 20 breaths per minute for the VPAP III models. Power consumption (and recommended battery capacity) will increase with higher respiratory rates.*

AutoSet CS2/VPAP Adapt powered with inverter

Device settings		Inverter		
EEP	**Median pressure support**	**Current draw at 12 V DC (amps)**	**Battery size for 8 hours use (amp-hours)** (includes 50% safety margin)	**Battery size for 8 hours use (amp-hours)** ***with H2i*** (includes 50% safety margin)
4	6	1.88	23	56
6	6	1.97	24	57
8	6	2.11	26	58
10	5	2.23	27	60

VPAP Malibu powered with inverter

Product	AutoSet pressure (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• VPAP Malibu	10	1.56	21
	20	2.35	29
• VPAP Malibu + Humidaire 2i	10	6.58	79
	20	7.53	91

VPAP Auto powered with inverter

- VPAP Auto

	AutoSet pressure <=10		AutoSet pressure >10	
PS (cm H_2O)	**Current draw at 12 V DC (amps)**	**Battery size for 8 hours use (amp-hours)** (includes 50% safety margin)	**Current draw at 12 V DC (amps)**	**Battery size for 8 hours use (amp-hours)** (includes 50% safety margin)
2	0.89	11	1.40	17
4	0.87	10	1.32	16
6	0.86	10	1.23	15
8	0.89	11	1.17	14
10	0.85	10	1.07	13

- VPAP Auto + Humidaire 3i

	AutoSet pressure <=10		AutoSet pressure >10	
PS (cm H_2O)	**Current draw at 12 V DC (amps)**	**Battery size for 8 hours use (amp-hours)** (includes 50% safety margin)	**Current draw at 12 V DC (amps)**	**Battery size for 8 hours use (amp-hours)** (includes 50% safety margin)
2	8.59	103	8.85	108
4	8.59	103	8.85	108
6	8.59	103	8.85	108
8	8.59	103	8.85	108
10	8.59	103	8.85	108

CPAP and auto CPAP powered with converter

Product	Treatment pressure* (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
• S8 Lightweight • S8 Escape	6	0.80	10
	8	0.90	11
	10	1.02	12
	12	1.12	13
	16	1.37	16
	20	1.66	20
• S8 Elite • S8 AutoScore • S8 AutoSet Vantage • S8 AutoSet Spirit • S8 AutoSet C • S8 Respond	6	0.90	11
	8	0.98	12
	10	1.09	13
	12	1.21	14
	16	1.46	18
	20	1.73	21
• S8 Elite II • S8 AutoScore II • S8 AutoSet Spirit II • S8 AutoSet • S8 Respond	6	0.57	7
	8	0.70	8
	10	0.84	10
	12	0.96	12
	16	1.22	15
	20	1.51	18
• S8 Escape II (EPR-setting 3)	5	0.41	5
	10	0.61	7
	15	0.86	10
	20	1.17	14

** As treatment pressure varies widely with automatic devices, 95th percentile pressure is used for all S8 AutoSet products.*

VPAP Malibu powered with converter

AutoSet pressure (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
10	1.09	13
20	1.74	21

VPAP Auto powered with converter

	AutoSet pressure <=10		AutoSet pressure >10	
PS (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)	Current draw at 12 V DC (amps)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
2	0.67	8	1.15	14
4	0.69	8	1.10	13
6	0.69	8	1.03	12
8	0.67	8	0.95	11
10	0.63	8	0.90	11

VPAP series powered with converter

IPAP (cm H_2O)	Current draw at 12 V DC (amps)	Battery size for 4 hours use (amp-hours) (includes 50% safety margin)	Battery size for 8 hours use (amp-hours) (includes 50% safety margin)
10	1.0	6	12
15	1.2	7	14
20	1.5	9	18
25	1.8	11	22