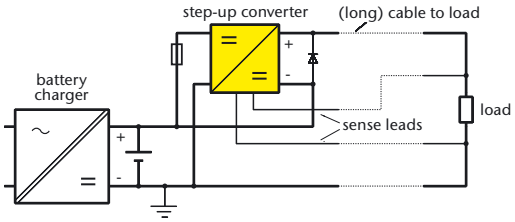
For output voltage stabilization

The output voltage of a battery charger with parallel connected battery varies substantially with the charging condition of the battery. For many applications however, the load circuit requires a better stabilized voltage. Frequently used methods for reducing the voltage variation are “voltage dropping diodes” or “systems with main and end cells” as presented on page 110. A more economical solution is given by switch mode step-up converters. These are DC/DC converters supplied by the battery with the output connected in series to the battery. Due to the circuit configuration, the output of a step-up converter is not insulated from the input supply (battery).

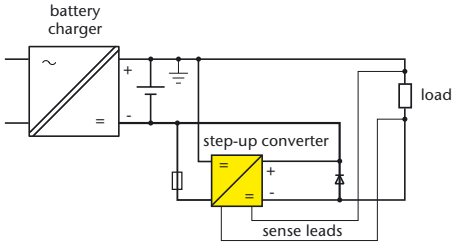
Step-up converter with common negative line

The following circuit diagram shows a step-up converter which can be grounded on the negative side. The voltage will be added at the positive side and the negative line is common for input and output.



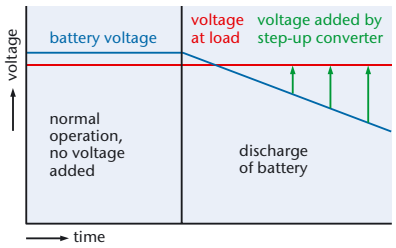
Step-up converter with common positive line

The following circuit diagram shows a step-up converter which can be grounded on the positive side. The voltage will be added at the negative side and the positive line is common for input and output.



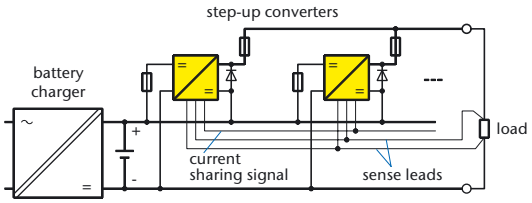
Operation diagram

- During normal operation no voltage needs to be added and the converter runs with a minimum of power losses. The voltage at the load is slightly reduced as the current flows through the bypass diode. The bypass diode also allows the replacement of the step-up converter and should therefore be installed externally.
- During battery discharge the converter adds the voltage that is needed to maintain the required output voltage level.
- The maximum voltage to be added is normally less than 20 % of the total voltage. Therefore, the step-up converter needs to be designed for only 20 % of the total power.



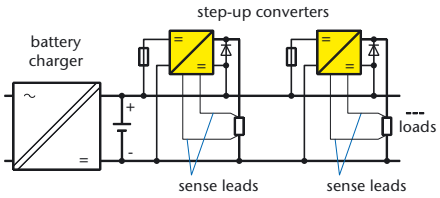
Parallel operation of step-up converters

For more power or redundancy, step-up converters may be connected in parallel with active current sharing, individually protected by fuses at the input and decoupling diodes or fuses at the outputs. Such systems have already been realized for 2,000 Amps.



Individual load supply

For applications that require individually stabilized voltages across the loads, the step-converters will be connected as shown in the following drawing and may be of different power ratings.



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Create your step-up converter

The step-up converters are very similar to the DC/DC converters of series **"C"**, with the speciality that the step-up converters sense the voltage across the load which is the total of the battery voltage and the voltage added by the step-up converter. Therefore, each DC/DC converter can be modified to be a step-up converter:

- calculate the output power of the step-up converter: max. voltage to be added x max. load current
- choose the suitable **"C"** series (see page 1)
- re-name the model as **"E"** ...

The step-up converter can not reduce the voltage being applied to its input. Therefore, the load should be specified for the maximum battery voltage.

DC in — DC out

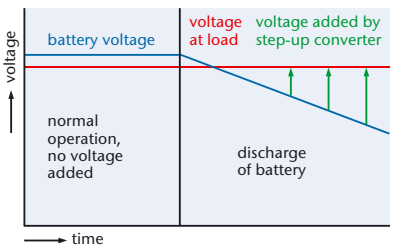
DC / DC Converters (example of page 32)

► 1000 W	► 1250 W									
Input VDC									Output VDC	
18–36 VDC	Output Amps	36–75 VDC	45–90 VDC	80–160 VDC	160–320 VDC	320–380 [1] VDC	320–640 [3] VDC	Output Amps	Adj.	Range
C 3720	120 [2]	C 3730	C 3740	C 3750	C 3770	C 3780 Z	C 3770 G	150 [2]	5	4.5– 5.5
C 3721	80	C 3731	C 3741	C 3751	C 3771	C 3781 Z	C 3771 G	100	9	8– 10
C 3722	70	C 3732	C 3742	C 3752	C 3772	C 3782 Z	C 3772 G	85	12	11– 13
C 3723	56	C 3733	C 3743	C 3753	C 3773	C 3783 Z	C 3773 G	70	15	14– 16
C 3724	40	C 3734	C 3744	C 3754	C 3774	C 3784 Z	C 3774 G	50	24	23– 26
C 3725	35	C 3735	C 3745	C 3755	C 3775	C 3785 Z	C 3775 G	42	28	26– 30
C 3729	19	C 3739	C 3749	C 3759	C 3779	C 3789 Z	C 3779 G	23	48	45– 55
C 3726	15	C 3736	C 3746	C 3756	C 3776	C 3786 Z	C 3776 G	18	60	58– 68
C 3727	8	C 3737	C 3747	C 3757	C 3777	C 3787 Z	C 3777 G	10	110	100– 130
C 3727 J	5	C 3737 J	C 3747 J	C 3757 J	C 3777 J	C 3787 ZJ	C 3777 GJ	6	200	190– 200
C 3728	4	C 3738	C 3748	C 3758	C 3778	C 3788 Z	C 3778 G	5	220	200– 250
C 3728 J	2.5	C 3738 J	C 3748 J	C 3758 J	C 3778 J	C 3788 ZJ	C 3778 GJ	3	400	380– 400

DC in — DC out

Step-up Converters

► 1000 W	► 1250 W									
Input VDC (battery voltage)									Output VDC	
18–36 VDC	Output Amps	36–75 VDC	45–90 VDC	80–160 VDC	160–320 VDC	320–380 [1] VDC	320–640 [3] VDC	Output Amps	Voltage at load regulated to	Step-up voltage
E 3720	120 [2]	**E** 3730	**E** 3740	**E** 3750	**E** 3770	**E** 3780 Z	**E** 3770 G	150 [2]		0– 5.5
E 3721	80	**E** 3731	**E** 3741	**E** 3751	**E** 3771	**E** 3781 Z	**E** 3771 G	100		0– 10
E 3722	70	**E** 3732	**E** 3742	**E** 3752	**E** 3772	**E** 3782 Z	**E** 3772 G	85		0– 13
E 3723	56	**E** 3733	**E** 3743	**E** 3753	**E** 3773	**E** 3783 Z	**E** 3773 G	70		0– 16
E 3724	40	**E** 3734	**E** 3744	**E** 3754	**E** 3774	**E** 3784 Z	**E** 3774 G	50	depen-	0– 26
E 3725	35	**E** 3735	**E** 3745	**E** 3755	**E** 3775	**E** 3785 Z	**E** 3775 G	42	ding on	0– 30
E 3729	19	**E** 3739	**E** 3749	**E** 3759	**E** 3779	**E** 3789 Z	**E** 3779 G	23	input	0– 55
E 3726	15	**E** 3736	**E** 3746	**E** 3756	**E** 3776	**E** 3786 Z	**E** 3776 G	18	voltage	0– 68
E 3727	8	**E** 3737	**E** 3747	**E** 3757	**E** 3777	**E** 3787 Z	**E** 3777 G	10		0– 130
E 3727 J	5	**E** 3737 J	**E** 3747 J	**E** 3757 J	**E** 3777 J	**E** 3787 ZJ	**E** 3777 GJ	6		0– 200
E 3728	4	**E** 3738	**E** 3748	**E** 3758	**E** 3778	**E** 3788 Z	**E** 3778 G	5		0– 250
E 3728 J	2.5	**E** 3738 J	**E** 3748 J	**E** 3758 J	**E** 3778 J	**E** 3788 ZJ	**E** 3778 GJ	3		0– 400



The photo shows a system consisting of three step-up converters E 3731 with input and output fuses installed in a sub-rack, designed for

- Input: 40 – 56 VDC (battery)
- Output: 0 – 10 VDC (step-up voltage) @ 3 x 100 A, output voltage regulated to 50 V

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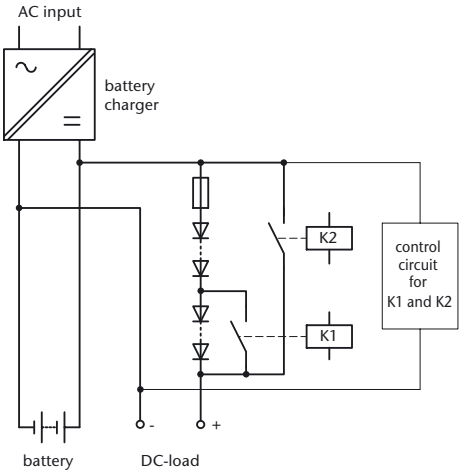
Output voltage stabilization

The output voltage of a battery charger with parallel connected battery varies substantially with the charging condition of the battery. For many applications, however, the load circuit requires a better stabilized voltage which can be accomplished by:

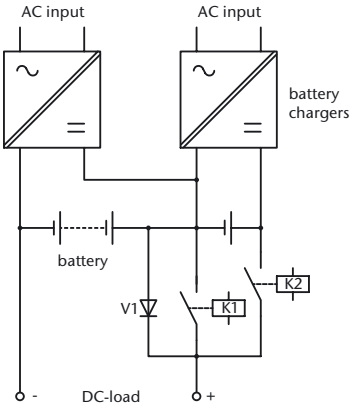
Voltage dropping diodes

being interconnected between battery and load, reduce the voltage to a value suitable for the load. They are short-circuited by one or more contactors if a partial reduction only or no voltage reduction is needed. A control circuit senses the battery voltage and energizes the contactors. Voltage dropping diodes cause substantial power losses as the excess voltage is absorbed by the diodes. However, due to the simplicity this method is frequently used, especially if the voltage reduction is needed during the short periods of high-rate charging only.



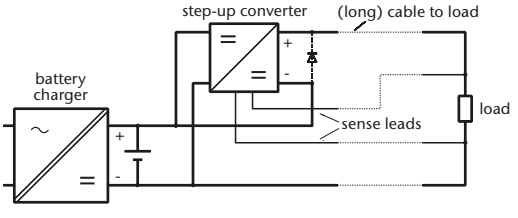
Systems with main and end cells

An economical but rather expensive solution occasionally used for high power systems is to split the battery into main and end cells. As during operation both sections are differently discharged individual chargers are needed. During normal operation, with the battery fully charged, the load circuits are connected via contactor K1 to the main cells. During mains failure the battery voltage decreases, contactor K1 opens and K2 connects the load to the entire battery. The diode maintains the current flow during switch-over. K1 and K2 are electronically controlled by a circuit that senses either the battery or the AC mains voltage.



Switchmode step-up converters

are DC/DC converters supplied from the battery with the output connected in series to the battery. They present a very economical solution as they only add voltage when the battery is discharged. Further details can be found on page 76 / 77.



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