ELECTRONIC CONTROL SYSTEMS

USER MANUAL BC-S Battery Chargers

BC-S Switch Mode Battery Chargers

12V/5A 12V/10A 24V/5A 12V/3A

Product Description:

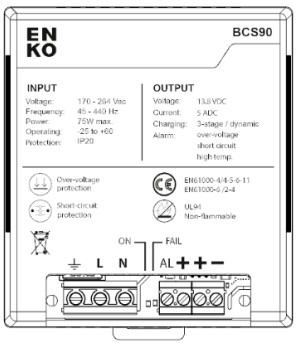
BC-S series battery chargers are designed as cost-effective high-reliability products, mainly targeting genset applications but are also suitable for all types of engine starter batteries. These chargers can charge all types of VRLA Lead Acid batteries with maximum performance.

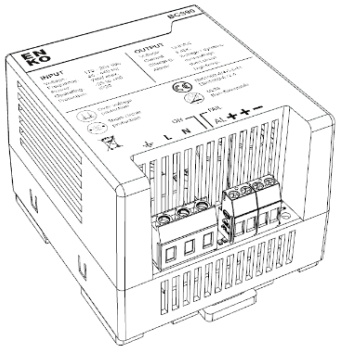
BC-S series chargers have a compact DIN rail mounting enclosure, but it can also be mounted on any panel type surface, using the optional “Panel Mount” brackets. The packaging offers IP20 protection class and therefore, must be mounted into an electrical cabin.

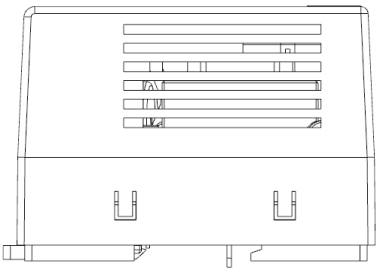
The product is designed with universal AC input voltage range for safe use in places, where mains fluctuation is outside standard limits. This feature also ensures adequate charging even when mains voltage is at very low limits. The standard model chargers can deliver full rated short circuit current into the batter, independent of the battery’s terminal voltage, hence, fully depleted batteries can be recovered and fully recharged with BC-S series chargers. Foldback current limited models cuts the output off, if low level activation voltage limit is reached, dissipating almost no power under these conditions.

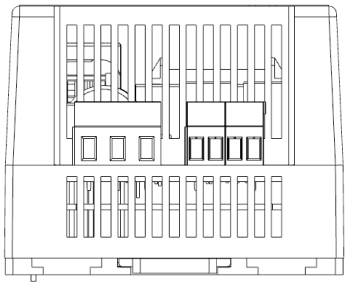
The charger is also equipped with an ALARM output signal. This signal can also drive an external alarm relay, where potential-free contacts are required. LED indicators on the front panel indicates normal operation of the charger unit or if there is a failure mode activated in the device.

All BC-S chargers can be arranged in a parallel connected configuration, which will increase the total charge current to the battery and/or provide redundancy in applications, where very high system reliability is important. In parallel configuration, all chargers share the load current and depending on total charge current requirement.









Model Description:

Five basic models are available in BC-S package:

- BCS 1205 SX
- BCS 1210 SX
- BCS 2405 SX
- BCS 1205 FX
- BCS 2403 FX

The model number also indicates the power rating of the charger package:

- 1205 and 2403 are 75W package,
- 1210 and 2405 are 150W package,

Foldback current limit models are designed to cut-off the output if the battery terminal voltage is below certain level (please check technical specifications table) and will automatically recover if the battery terminal voltage rises above the cut-off voltage value.

Order code format for standard 12V 5A charger unit with no boost function is explained below:

B	C	S	-	1	2	0	5	-	S	X

MODEL LEGEND

OUTPUT VOLTAGE	OUTPUT CURRENT	OPTION	
12	05	S	B / X
	10		
24	05		
12	05	F	X
24	03		

B = BOOST function
F = FOLDBACK current Limit function
X = NOT applicable

Order code variations are given in the format above and customer can choose required options from the table above. When ordering, please follow the above order code legend and if in doubt, please ask ENKO sales department for more detailed information.

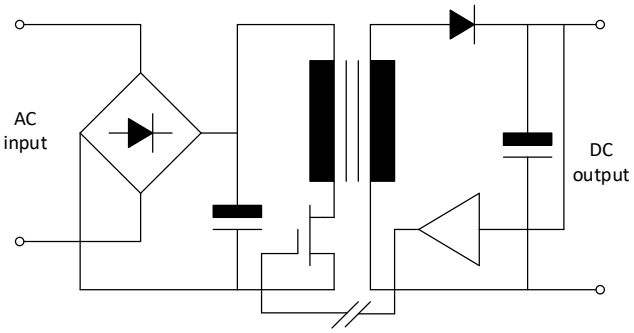
THIS USER MANUAL IS PREPARED ONLY FOR BC-S SERIES CHARGERS. FOR HIGHER POWER RATED MODELS, PLEASE REFER TO THEIR RESPECTIVE USER MANUAL DOCUMENTS, DIRECTLY AVAILABLE FROM ENKO.

Technical Specifications:

		Power rating (W):	**90**	**150**	
		Output voltage (Vdc):	**13.8**	**13.8**	**27.6**
		Output current (Adc):	**5**	**10**	**5**
Efficiency (Typical):		@230Vac input	84%	86%	
INPUT	Voltage:		88Vac to 264Vac or 140Vdc to 300Vdc (Withstanding 300Vac)		
	Frequency:		50Hz, 60Hz, 400Hz (47Hz to 440Hz)		
	Current (Typical):	110Vac @ 50Hz input	<1.85A	<3.0A	
		230Vac @ 50Hz input	<1.0A	<1.6A	
	Power factor (Typical):	230Vac input	0.45	0.47	
	Harmonic current limiting:		Not applicable		
	Leakage current (Typical):	110Vac @ 50Hz input	<0.30mA	<0.35mA	
		230Vac @ 50Hz input	<0.50mA	<0.55mA	
	Inrush Current (Typical):	110Vac @ 50Hz input	<17A		
		230Vac @ 50Hz input	<34A		
OUTPUT	Voltage ripple:	230Vac @full load	<0.1V pk-pk	<0.15V pk-pk	<0.25V pk-pk
	Load regulation:	230Vac @ 50Hz input	<1.5% from no-load to full load		
	Line regulation:	110Vac to 264Vac input	<0.5% at full load		
	Temperature drift:	230Vac @ 50Hz input	<0.2% at full load (+0.2% above 50°C)		
	Start delay:	110Vac @ 50Hz input	<1.5s @ room temperature		
		230Vac @ 50Hz input	<1.2s @ room temperature		
	Hold-up time delay:	110Vac @ 50Hz input	>25ms	>20ms	
		230Vac @ 50Hz input	>80ms	>35ms	
FUNCTIONS	Overload protection:		105% @ 3dB roll-off, short circuit protected, continuous		
	Overvoltage protection:		+50% of nominal output voltage across output terminals		
	Reverse polarity protection:		Active protection, no external fuse required		
	Series connection configuration:		Not allowed		
	Parallel connection configuration:		Refer to the user manual for recommended configuration		
	Boost function (optional):	Boost o/p voltage (Vdc)	14.5	14.5	29
		Boost power (W)	Approximately 70% of rated power		
	Foldback current limiting:	Activation battery voltage	<9Vdc		<18Vdc
	Ambient operating temperature:		-25°C to +60°C		
	Storage temperature:		-25°C to +65°C		
	Ambient operating humidity:		20%RH to 90%RH non-condensing		
	Insulation resistance:		>100MΩ input/output to PE @ 500Vdc		
	Galvanic isolation	Input to output	>2.7KVac for 1 minute		
		Input/output to Earth	>1.5KVac for 1 minute		
	Vibration resistance:	10Hz to 55Hz	0.3mm pk single amplitude, 2h on each X, Y and Z axis		
	Shock resistance:	3 times per axis	5g on X, Y and Z axis		
	Indicators:	Power	Green		
		Fail	Red		
	EMI	Conducted emission	EN55011 Class A		
		Radiated emission	EN55011 Class A		
	Compliant standards		CE, UL1236		
	Enclosure protection class:		IP20		
	Dimensions:		100 x 90 x 71 mm		
	Weight:		240gr	270gr	270gr
	Packaging:		Bulk packaging in carton box, individual packaging opt.		

Principle of Operation:

System block diagram is shown below:



Incoming mains power is rectified and used as DC source for the switching power stage. A high frequency transformer is used to provide galvanic insulation between the mains input and DC output.

A feedback circuit controls the output DC regulation to charge the battery bank. Via same feedback circuit, charger output current is also limited to make sure that; it does not exceed the set limit, also providing short circuit protection.

Due to its high switching frequency, overall efficiency is high.

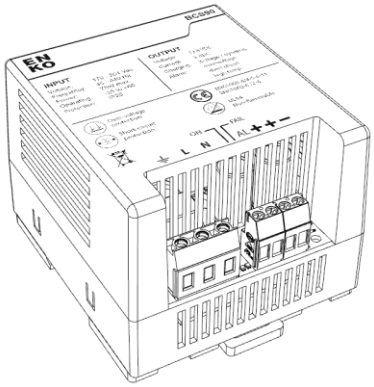
An active reverse polarity protection is also provided to ensure that; charger is not damaged if the battery terminals are connected in the wrong position. No additional fuse is required for the reverse polarity protection.

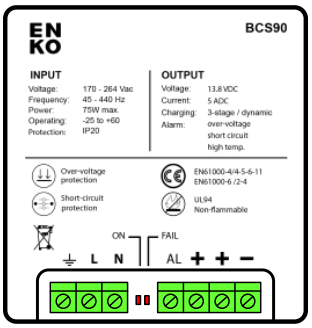
In FOLDBACK current limited models, current limit is set to maximum rated value, if the battery terminal voltage is above “foldback current limit” activation level. Below the activation voltage level, current limit is reduced to a few milliamperes, dissipating almost no power. If battery voltage exceeds the activation level, conditions will be restored.

Terminal description:

BC-S series chargers are equipped with screw type terminals for installation. Please refer to the cable size table before attempting to install the charger.

Charger terminals are shown in the figure below:





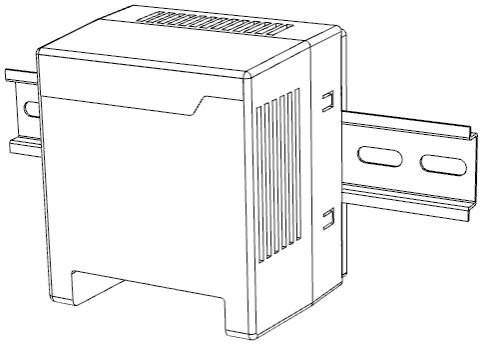
T1				T2			
1	2	3		1	2	3	4

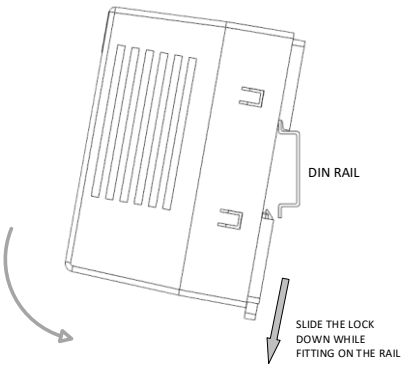
Nomination	Description	Terminal	Cable specifications
MAINS INPUT	Earth connection	T1/1	1.0mm^2 multi-stranded cable, 1KV minimum insulation class. (Do not use solid copper wire)
	Live connection	T1/2	
	Neutral connection	T1/3	
DC OUTPUT	Alarm signal output connection	T2/1	1.0mm^2 stranded copper cable
	+DC power output connection	T2/2	1.5mm^2 stranded copper cable (Use 2.0mm^2 stranded copper wire for 10A charger)
	+DC power output connection	T2/3	
	-DC power output connection	T2/4	

Installation:

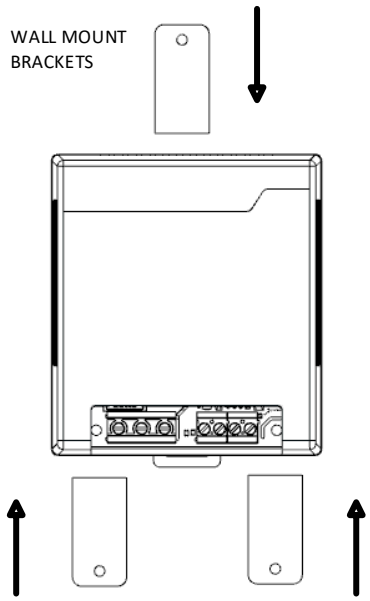
BC-S charger enclosure is designed as a DIN-Rail mount device and must be mounted in vertical position. Heated component cooling is optimised in vertical mount position. Mounting the charger in any other position will degrade device cooling and will cause early shutdown.

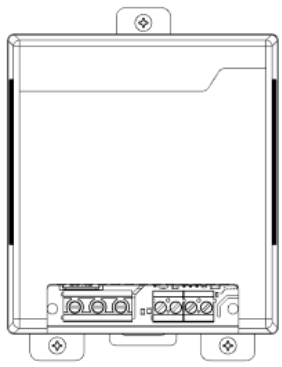
Valid mounting position is shown below:





Ensure to pull the rail lock down with a suitable screwdriver before placing the unit on the DIN rail, then release the lock and ensure that it grips the rail tightly.



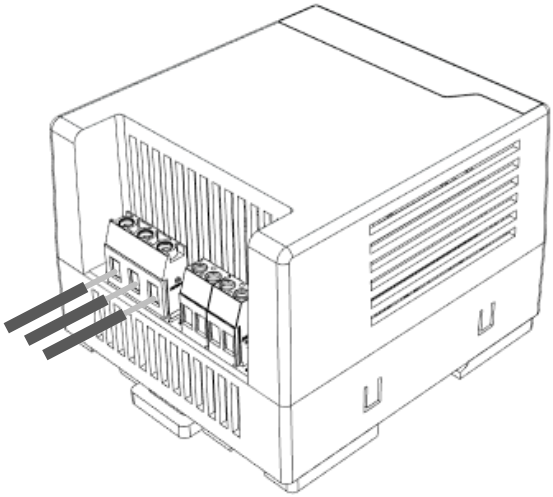


For wall mounting, use the wall-mount brackets (optional) and slide the brackets into their place on the back side of the charger enclosure. Use M3 self-tapping steel screws to fix the charger onto the mounting surface. First install the bottom brackets, fix the charger on the wall, then fix the top bracket. Ensure that; the charger is fixed securely on the wall and in vertical position.

When connecting the wires, care should be taken to prepare the wire-end for each terminal. Do not peel the cable sleeving too much such that, bare wire ends can cause short circuit between the adjacent terminals. Measure the wire stripper setting so that, only 10mm is stripped on the wire. When connecting to the terminals, push the wire all the way to the limit, where the sleeving starts.

DO NOT TIGHTEN THE TERMINAL SCREW DIRECTLY ONTO THE CABLE INSULATION. MAKE SURE THAT, ONLY BARE COPPER WIRE SECTION IS PUSHED INTO THE TERMINAL OPENING AND SCREW TIGHTLY. REFER TO THE TERMINAL DESCRIPTION TABLE ABOVE FOR WIRE SIZE SELECTION.

Check the diagrams below for correct wiring of the terminals:

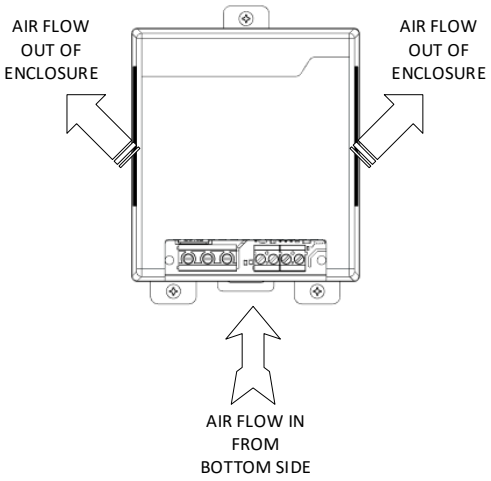


Enable convection:

This device contains heat generating components and they must be sufficiently cooled for proper operation. Therefore, care needs to be taken while mounting the device in a closed electrical cabinet. Heat is generated inside, and heated air is transferred out of the enclosure by free-flowing air from the bottom side and from the openings on each side of the enclosure. Please observe the mounting rules shown below,

It is recommended that, at least 50mm obstacle-free space is leaf at the bottom side of the charger during mounting for easy airflow from the bottom side of the charger unit.

Also, ensure that there is at least 35mm gap left on each side of the charger unit for the hot convection air to flow freely out of the charger enclosure. If possible, leave around 50mm gap on each side of the charger.



There are no very hot surfaces on the charger enclosure, since the heatsink in mounted inside the plastic case.

Choosing the correct charger rating:

Wiring the charger into your system requires few simple steps. Ensure that; you have chosen the correct voltage and current rating of the charger for your battery system. Using wrong type of charger for your battery system will cause poor performance and your battery bank may never be charged to its full state.

You can follow the next steps to choose the correct charger rating:

1. Battery Ah capacity: Ah
2. Battery standby load: I_L
3. Maximum charger capacity: I_C

$$I_C \geq 0.1xAh+I_L$$

For example:

If your battery Ah capacity is 60Ah and your continuous load current connected to the battery is around 1A, then you must select a charger with output current capacity of:

$$I_C = 0.1x60 + 1$$

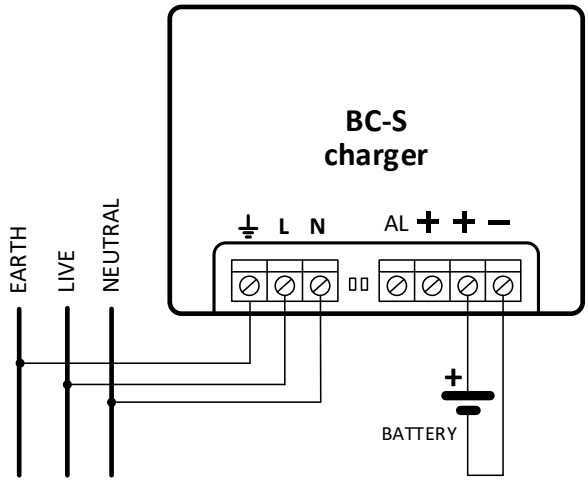
$$I_C \geq 7A$$

In this case, it is always a better practice to choose a 10A rated charger, rather than 5A rated charger. This choice must be made by the user, considering the engine cranking repetition rate and the operating conditions of the system. Choosing a higher current rating is always a better practice.

Connecting charger to the battery system:

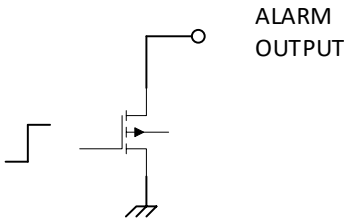
Ensure that, charger location is compatible with the protection class of the battery charger unit. BC-S series chargers are designed according to IP20 protection class and precautions must be taken according to this level. Please also check if correct charger voltage rating is selected for battery to be connected. Failing to choose the correct voltage rating will cause system failure.

Basic connection diagram is shown below:

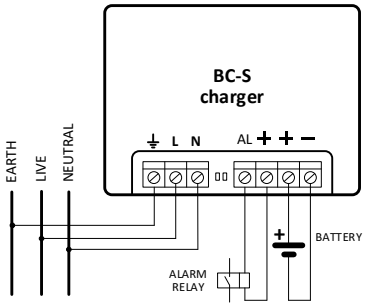


CHECK BATTERY TERMINAL VOLTAGE VALUE AND MAKE SURE THAT, YOUR CHARGER HAS THE CORRECT VOLTAGE RATING TO MATCH YOUR BATTERY. REFER TO THE TERMINAL DESCRIPTION AND WIRE GAUGE TABLE BEFORE ATTEMPTING TO CONNECT WIRES TO YOUR CHARGER.

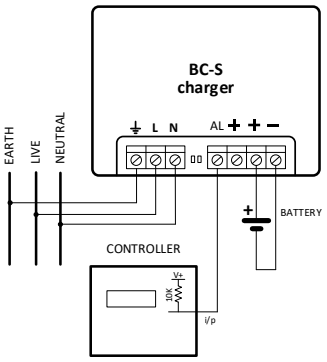
The ALARM output of BC-S series chargers is designed as "Solid-State" transistor output, which sinks the load to GND, when activated. When not active, it is in "high impedance" state. ALARM output configuration is shown below:



If ALARM function is going to be used with an external relay, refer to the connection diagram below:



If ALARM function is going to be used with a control unit, then there is no requirement for an external relay. Please refer to the connection diagram below:



An internal pull-up resistor may be required, depending on the control unit's input hardware configuration.

Ensure that the alarm relay coil voltage matches the DC battery voltage, since the relay is connected directly to the DC bus. Relay contact rating should be chosen according to application requirement.

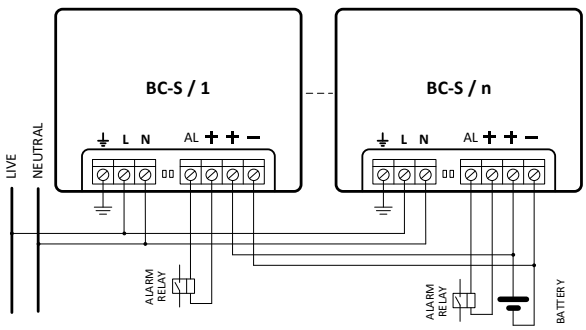
Parallel configuration:

In some applications, it may be necessary to increase the charge current capacity or create redundancy in critical applications. In this case, multiple chargers can be connected in parallel to increase the charge capacity. Only similar models can be connected in parallel. There are some rules to be considered for parallel configuration and these are explained below.

In theory, there is no limit to how many chargers can be connected in parallel, but it is recommended not to exceed 5 units in parallel as this may cause higher standby current consumption from the battery and at the same time, decrease the overall efficiency. In such a case, choose a higher rated single battery charger from ENKO battery charger range.

Parallel connected chargers will share the load current, depending on each charger's specific output voltage setting. Therefore, if the load current is varying, the number of chargers feeding the load line will vary but at any time, load demand will be supplied precisely by the chargers connected in parallel configuration. If any one of the chargers fail to operate, remaining chargers in the parallel configuration will carry on supplying the demanded load current.

Please follow all the instructions given below for multiple charger applications. If in doubt, please call ENKO technical help service line for further information.

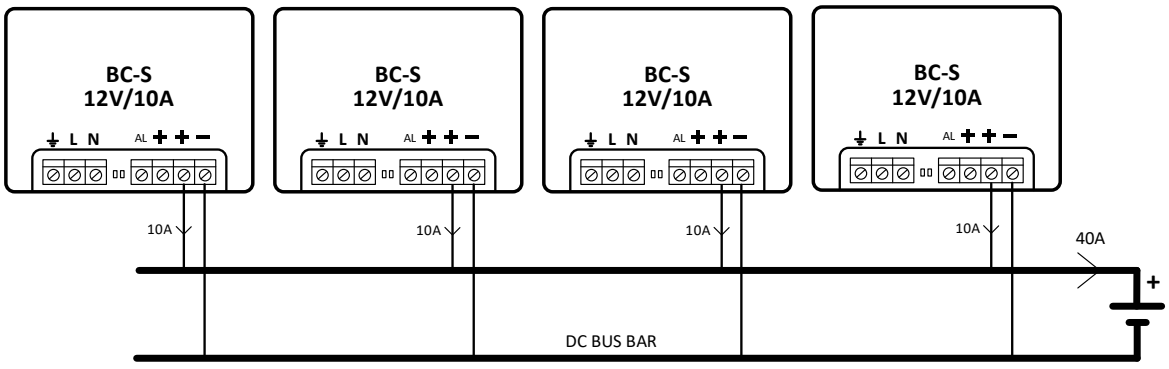


If ALARM relay connection is required, each charger must have their own alarm relay connected as shown in the above parallel configuration application. This is necessary as each ALARM output must be active (energized) under normal operating conditions. The output of each relay can be connected in AND configuration for single alarm signal.

When multiple chargers are connected in parallel, daisy-chain load wire connection must be avoided if more than 2 chargers are used. Maximum wire size is limited to 2mm^2 for the chargers and if more than 2 chargers are connected in parallel, accumulated load current through the wire will exceed the maximum current capacity of the wire.

Therefore, in such applications, each charger load wire must be connected to a common DC busbar, where full battery charge current can be handled safely.

Refer to the example given below, utilising 4 numbers of 12V/10A chargers connected in parallel.

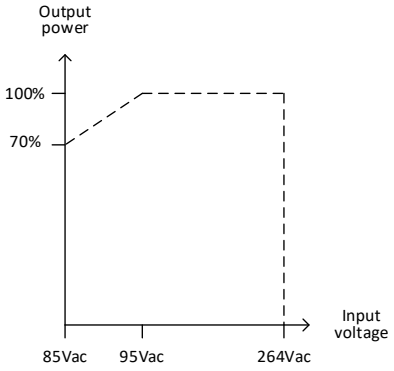


In the example given above, total battery charging current is 40A and maximum allowed cable size for charger terminals is 1.5mm^2 therefore, daisy-chain wiring of the chargers is not a good practice as the current density across the wire will accumulatively increase to 40A, which the wire cannot carry.

In this case, use a solid common DC BUSBAR and connect each charger to this common DC Busbar with its recommended wire type. This method will eliminate excessive heating of the charger wires and potential failure of the charging system. In practice only 2 chargers can be connected in daisy-chain method in parallel configuration, more charger groups must be wired with DC BUSBAR method.

Input power derating:

BC-S series chargers are designed for universal AC input specifications. But below minimum operating input AC voltage range (110Vac – 15%) full rated DC output power is derated according to the graphics given below:



Input power derating also changes with the operating environment temperature, and this must be taken into account, when calculating maximum available output power from the charger at any given operating conditions.

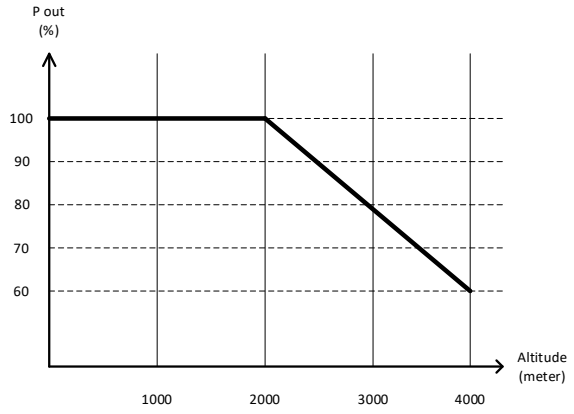
Charger output power is not derated according to the operating environment temperature. Care must be taken to avoid operating temperatures, exceeding the specified device limits.

The input power derating curve is a “typical” characteristic curve and devices may have varying performance based on the component tolerance limits.

Output power derating vs altitude:

Total device cooling is reduced as the operation altitude is increased. Therefore, certain power derating is required based on the altitude and also the ambient temperature of the charger location. The combined power derating is given in the table below:

Since the total derating curve is a combination of cooling capability of the environment, temperature compensated derating must depend on the local conditions and the graphic is given as a general indication of the BC-S characteristics.

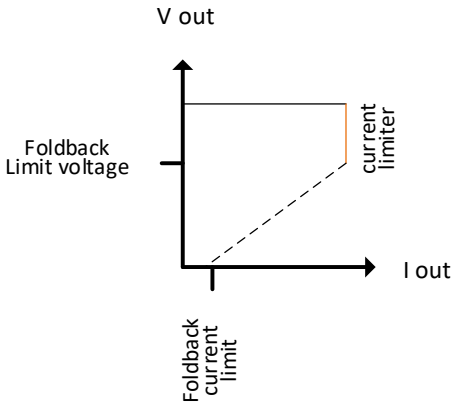


Foldback current limit function:

BC-S series chargers also have FOLDBACK CURRENT LIMIT function models, which can be a good choice for low-cost reliable applications. This function behaves same as the standard models, but the output current is reduced if the charger output is forced below a certain voltage level. Foldback current limit characteristics is given int the following graphics:

If battery terminal voltage is below approximately 70% of its rated voltage, foldback current limit function will limit the current and switch the output current to a few hundred milliamperes, in order to limit the power dissipation.

In this case, charger continuously controls the output terminal voltage level and once the voltage level exceeds the minimum foldback current limit activation voltage level, the current limit is restored to full rated current limit and starts to charge the battery.



During foldback current limit state, the charger dissipates a very small power, hence allowing a long-term reliable charging lifetime for the system.

In foldback current limit model, there is no BOOST function available.

Reverse polarity protection:

BC-S series battery chargers have “built-in” active reverse polarity protection and device will automatically shut down safely if the battery terminals are connected in the wrong polarity. Charger will indicate a FAILURE MODE with the LED indicator placed between the terminals.

The charger will recover from this failure mode once the cause of failure is removed. The device will operate according to its specifications, when connected to the battery with the correct polarity. There is no need for an external fuse connection. If fuse is used, due to protection function, the fuse may not be tripped and will have no useful function.

Over-temperature protection:

BC-S series chargers are equipped with a primary side temperature sensor, which senses the charger enclosure environment temperature. Heated components gradually increase the internal temperature of the charger unit and if the temperature reaches limit values, the charger will shut down with no warning.

Charger unit will automatically start to operate once the sensor temperature falls below maximum limit. If the cause for high temperature is not eliminated, the device will shut down again once upper operating temperature limits is reached.

For temperature protection, there is no indication. Therefore, user must be aware of this condition and if there is no output available from the charger, the temperature of the device must be observed during trouble shooting exercise.

Output over-voltage safety:

The output circuitry of these chargers is designed in such a way that, even if there is a high voltage across its output terminals, the charger will not be damaged. Maximum over-voltage withstanding capability of these chargers is limited to 35Vdc across its output terminals.

There is no indication for over-voltage condition across the output terminals. Ensure that; any external charging devices acting on the same battery is safely controlled.

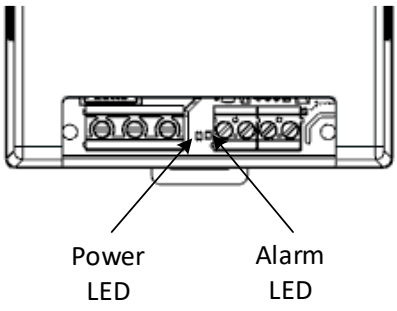
Short circuit protection:

BC-S series chargers are “short circuit” protected and can deliver full rated output current under short circuit conditions. There is no limit how long the unit stays in short circuit condition. This feature makes BC-S series chargers superior to other chargers on the market. If the battery is completely depleted and its terminal voltage is very low (similar to short circuit conditions), BC-S series chargers can recover the battery from its depleted condition to a fully charged condition. There is no minimum battery terminal voltage limit, which it can be charged from.

In FOLDBACK current limited models, there is no indication if the unit is in foldback current limiting state. Therefore, during trouble shoot exercise, one must check the battery terminal voltage before taking any action.

LED Indication:

The charger unit is equipped with two LED indicators, placed on the pcb between the mains terminal and output terminal block. LED indicator identification is shown below:



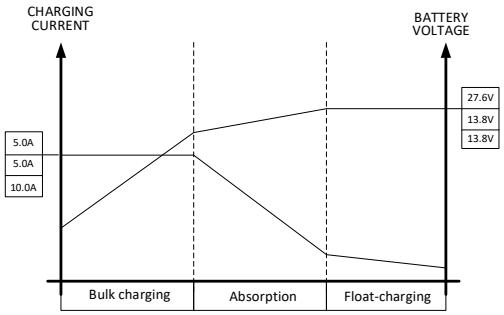
The LED indication is described in the table below:

Description	Power LED	Alarm LED
Power off, no	OFF	OFF
Power off, battery connected	OFF	ON
Power on, battery connected	ON	OFF
Power on, o/p short circuit	OFF	OFF
Power on, o/p overvoltage	ON	OFF
Reverse polarity connection	OFF	ON

Alarm output is connected together with the alarm LED and is normally ENERGIZED when there is NO ALARM condition. This means that; alarm output is only active if battery is connected and there is no power at the input of the charger.

Charging characteristics:

ENKO chargers are designed according to various types of charging characteristics. Among them, BC-S series chargers are designed according to 3-stage dynamic charging concept and the charge characteristics are explained below:



During BULK stage, battery is depleted, and terminal voltage is low, and charger delivers full rated current into the battery. During this phase, battery terminal starts to rise.

During ABSORPTION stage, the battery capacity is recovered near its full state, but battery is chemically still not stable and more current is required to complete the charge function. At the end of this stage, battery is charged to nearly above 90% of its capacity.

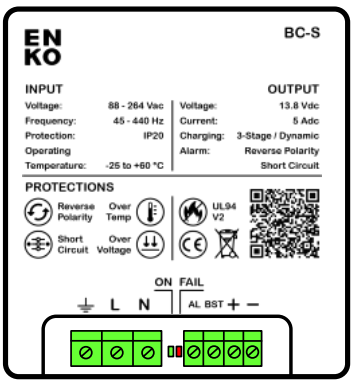
During FLOAT stage, battery is equalised, and charger delivers only the required current into the battery to compensate for its internal losses. During the float stage, battery is normally charged to nearly 95% of its capacity and this changes according to battery health condition.

Boost Charge function:

"BOOST Charging" function is an option in BCS series chargers. This feature is described in this chapter and user is recommended to connect the system according to the information provided in this manual. Please also observe the specific behaviour of the charger when BOOST function is activated.

Boost terminal is placed next to the ALARM output terminal. In this model, one of the +'ve terminals is replaced with the BOOST function control input terminal. Therefore, please follow instructions given in this manual. Front terminal connection layout is given below:

In BOOST option model, terminal number T2/2 is used as BOOST control input and must be connected to battery +'ve terminal for activation.



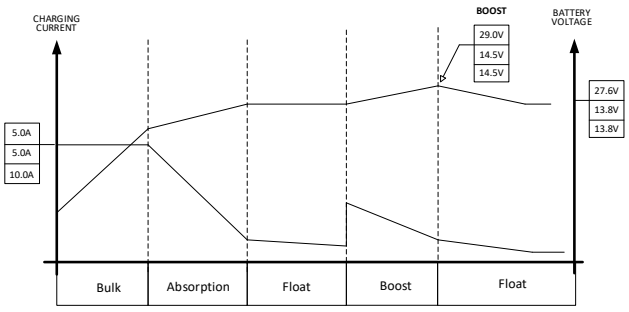
T1				T2			
1	2	3		1	2	3	4

BOOST function will stay active, as long as the BOOST control terminal is connected to battery +'ve terminal-potential. Therefore, BOOST duration must be controlled with an external control unit.

During BOOST active duration, charger output voltage level and power limit is changed according to the table below:

Normal	Boost	Power
13.8Vdc	14.5Vdc	Apprx. 70% of rated power
27.6Vdc	29.0 Vdc	

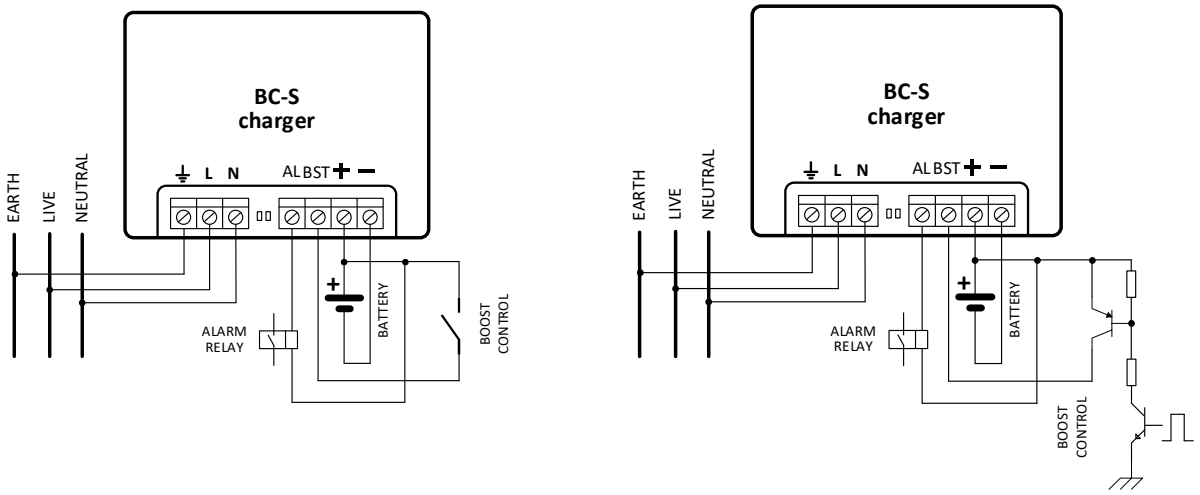
Output power limitation is required in order to protect the battery health during BOOST charging mode. Since battery temperature is not measured, power is limited to approximately 70% of rated output power and this ensures that, battery electrolytes do not get overheated during charging.



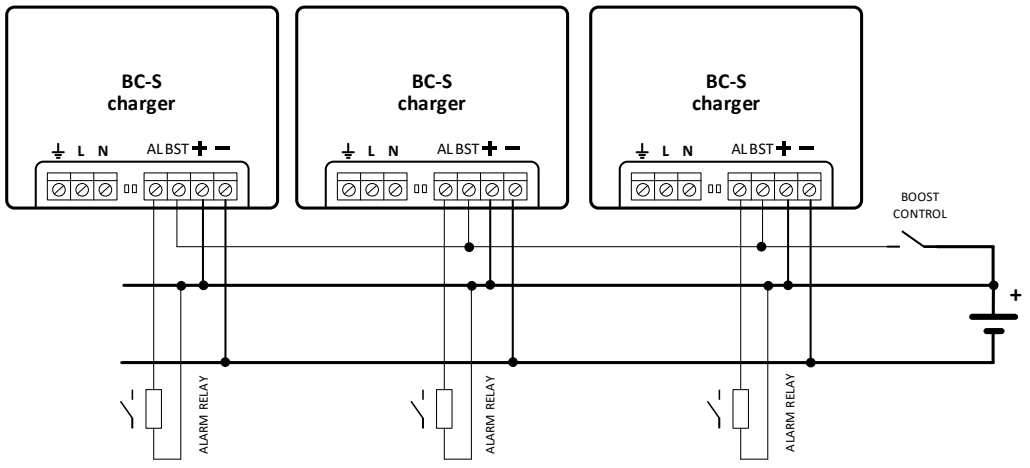
BOOST charging function must be controlled with an external control device, such that, activation repetition period and active duration should be set to keep battery health at its top state.

Boost mode connection configurations:

With BOOST option, connecting single charger and multiple redundant chargers are shown in the drawings below. Since BOOST control terminal is “active-high”, this terminal must be connected to V+ (battery positive terminal) for activation. Do not apply a different voltage than the battery voltage as this may damage the control input. A potential-free relay contact is suitable for this purpose, as shown in the examples below. If solid-state control is going to be used, a PNP type transistor or P-channel MOSFET can be used.



If parallel connection is required, this is also possible with BOOST function enabled. Such multiple chargers connected in parallel is shown as an example below:



Service and repair:

BC-S series chargers are designed as no-service units. There are no serviceable parts inside the unit. If the unit fails to operate, please return it to the factory.

Please do not dispose in directly into the waste box as there are components inside the unit, which may cause harm to environment if disposed freely. If it is not possible to send back to the factory, use authorised disposing companies to get rid of the failed unit.

If the unit is under guarantee when failure happens, the unit will be replaced free-of-charge if the failed unit is returned to the factory. Failed units can be repaired at the factory if required.

TROUBLE SHOOTING:

Following information is given as a guide, this user manual does not intend to solve all the failure modes for BC-S series chargers. It is also beneficial if the person troubleshooting the charger systems is an experienced technician.

1- MAINS CONNECTED, NOT CHARGING:
- Check if mains power is available and healthy. Connect a multi-meter and read the AC input voltage terminals, make sure reading is within the specified limits,
- Check if the output terminals are short circuit or not,
- If foldback limit model, check the output terminal voltage, ensure it is above activation voltage limit,
- Check battery terminal connection polarity, ensure correct polarity and try again,
- Check the LED indicators on the pcb,

2- MAINS CONNECTED, NO LED INDICATION:
- Disconnect the battery terminals and measure the output terminal voltage, ensure correct voltage is present.
- Check mains power is available at the input terminals of the charger,
- Check if there is an active alarm condition or not,
- Check if the charger is in current limit condition or not, if charger is connected to nearly depleted battery, output may be practically in short circuit condition and although charger is delivering full rated current into the load, both LEDs will be in OFF position. This means the charger is operating correctly.
- Ensure terminal screws are tightened properly,

3- ACTIVE ALARM:
- Check from LED table that no alarm is active,
- Check if there is mains power available at the mains input terminals of the charger,
- Check if the cable terminals are tightly screwed, if not, tighten the terminals and try again,
- Remember that; ALARM relay is energized (active) when there is no active alarm condition, in other words, alarm relay should be energized if everything is healthy,
- Disconnect the battery terminals and check the alarm output again,