Optimal Battery Charging Algorithm in Hybrid Systems

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INTRODUCTION

Global rising trends in energy consumption and reduced natural energy sources focus attention on optimizing efficiency in hybrid energy systems. To get higher efficiency from a hybrid solution we need to optimize the battery charging phase. Lead acid batteries are one of the most expensive parts of hybrid system and therefore it is necessary to maximize its life.

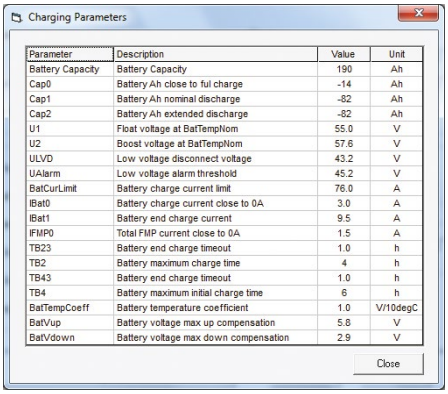
International standard IEC62509:2011 "Battery charge controllers for photovoltaic systems - Performance and functioning" was established to provide guidelines to ultimately reduce energy wastage. UNIPOWER manufactures a battery charge controller HCX Advanced that, when used with lead acid batteries in terrestrial photovoltaic systems, provide a simple system that meets these standards. Together in conjunction with IEC62093 which describes test and requirements for intended the installation application, it includes but not limited aspects such as safety, physical connection sturdiness and enclosure.

The optimal battery algorithm for exact type of cyclic battery used in hybrid system is achieved by a battery file. It is a part of configuration file used in the controller. Major battery manufacturers' recommendations for charging are individually provided and include parameters such as bulk charge rate/voltage, float voltage, equalise time/voltage, temperature compensation factor, battery optimal depth of discharge; saving any guess work by the user.

Based on battery parameters the controller calculates the charging parameters. These are exact values of battery capacity, current, time or voltage which define conditions for ending or starting one of the phases in battery charging cycle.

The HCX controller works with a status machine which automatically indicates the currently running phase of battery charging in a hybrid system.

The HCX battery charge controller provides the essential function of managing battery and generator cycling, and ensuring maximum energy harvest of renewable energy sources. It collects data about battery, fuel consumption, generator status and output power to provide complete statistics of the performance of the site. Alarm and warning notifications are indicated by front panel LEDs, and through potential free alarm contacts that allow remote signaling. External monitoring of alarms is accomplished through a USB or RS232 port using PC-based PowCom™ hybrid software. The HCX has an Ethernet port allowing control over a TCP/IP network and web based support. Alarms can be mapped via SNMP traps. To meet individual site requirements, the HCX contains a Programmable Logic System (PLS) that can be used to monitor and control specified customer requirements.

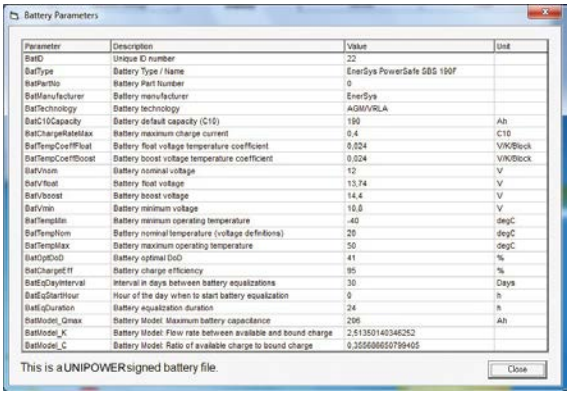


Parameter	Description	Value	Unit
Battery Capacity	Battery Capacity	190	Ah
Cap0	Battery Ah close to ful charge	-14	Ah
Cap1	Battery Ah nominal discharge	-82	Ah
Cap2	Battery Ah extended discharge	-82	Ah
U1	Float voltage at BatTempNom	55.0	V
U2	Boost voltage at BatTempNom	57.6	V
ULVD	Low voltage disconnect voltage	43.2	V
UAlarm	Low voltage alarm threshold	45.2	V
BatCurLimit	Battery charge current limit	76.0	A
IBat0	Battery charge current close to 0A	3.0	A
IBat1	Battery end charge current	9.5	A
IFMP0	Total FMP current close to 0A	1.5	A
TB23	Battery end charge timeout	1.0	h
TB2	Battery maximum charge time	4	h
TB43	Battery end charge timeout	1.0	h
TB4	Battery maximum initial charge time	6	h
BatTempCoeff	Battery temperature coefficient	1.0	V/10degC
BatVup	Battery voltage max up compensation	5.8	V
BatVdown	Battery voltage max down compensation	2.9	V

The HCX communicates internally on an RS485 bus with AC/DC and DC/DC modules based on Guardian platform. For future features expansion it is possible upgrade HCX firmware locally via the USB port or remotely via the Ethernet connection.

Site daily logs which are stored on SD card are possible to view and analyse in a graph form by Hybrid CSV Reader software.

Please see more detail of controller specifications within individual data sheets at www.unipowerco.com.



Parameter	Description	Value	Unit
BatID	Unique ID number	22	
BatType	Battery Type / Name	EnerSys PowerSafe SBS 190F	
BatPartNo	Battery Part Number	0	
BatManufacturer	Battery manufacturer	EnerSys	
BatTechnology	Battery technology	AGM/VRLA	
BatC10Capacity	Battery default capacity (C10)	190	Ah
BatChargeRateMax	Battery maximum charge current	0.4	C10
BatTempCoeffFloat	Battery float voltage temperature coefficient	0.024	V/K/Block
BatTempCoeffBoost	Battery boost voltage temperature coefficient	0.024	V/K/Block
BatVnom	Battery nominal voltage	12	V
BatVfloat	Battery float voltage	13.74	V
BatVboost	Battery boost voltage	14.4	V
BatVmin	Battery minimum voltage	10.8	V
BatTempMin	Battery minimum operating temperature	-40	degC
BatTempNom	Battery nominal temperature (voltage definitions)	20	degC
BatTempMax	Battery maximum operating temperature	50	degC
BatOptDoD	Battery optimal DoD	41	%
BatChargeEff	Battery charge efficiency	95	%
BatEqDayInterval	Interval in days between battery equalizations	30	Days
BatEqStartHour	Hour of the day when to start battery equalization	0	h
BatEqDuration	Battery equalization duration	24	h
BatModel_Qmax	Battery Model: Maximum battery capacitance	206	Ah
BatModel_K	Battery Model: Flow rate between available and bound charge	2,51350140346252	
BatModel_C	Battery Model: Ratio of available charge to bound charge	0,355606650799405	

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