CHARGE CONTROLLER

C C S 9 3 1 0 C T C

D a t a s h e e t

Applications for the *CCS-System*:

Alarm Systems, Cellular Phones, Computer, Electric Vehicles, HiFi, Hobby, Instruments, Lamps, Medical Electronics, Pager, Portables, Radio, Solar Systems, Telephone, Tools, Toys, UPS, Video..

Microcomputer with CCS for Rechargeable Batteries:

Features:

☺ Microcomputer controlled quickcharge up to 100% exactly in 20-30 minutes
☺ No overcharge, no memory effect
☺ Extended battery life, >5000 cycles
☺ Independent of battery type: NiCd, NiMH, Lead acid (Pb), etc.
☺ Number of cells unlimited
☺ Automatic recharge, MC controlled
☺ Standby operation
☺ Independent of precharging state, no discharge needed
☺ Reliable function also with protection diodes in the battery pack
☺ Simple handling, fail-safe by watchdog control
☺ Independent of external influences (e.g. temperature)
☺ Battery fault detection (LED & buzzer signal)

Characteristics:

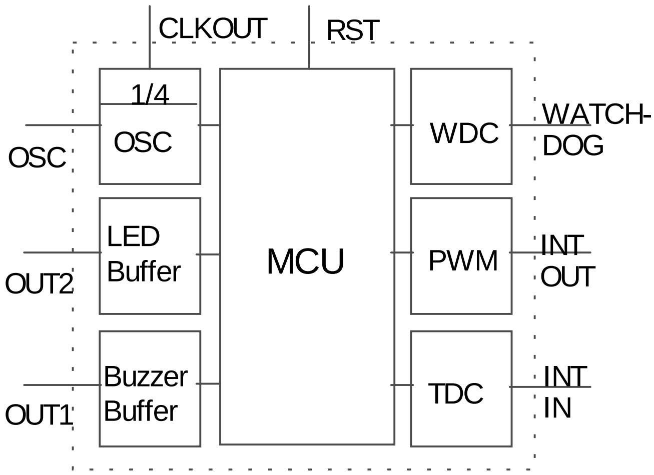
Input voltage:	2.5V to 6.25V
Low power:	< 2 mA
Package:	PDIP 18

Operating temperature:

Commercial:	0 to +70 °C
Industrial:	-40 to +85 °C

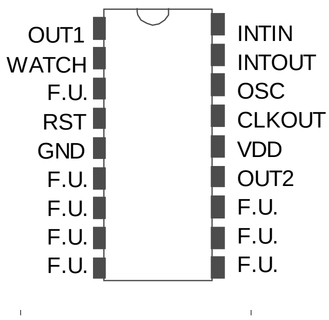
Storage temperature:	-65 to +150 °C

Block Diagram:



Pin Configuration:

1	OUT 1 (Buzzer)	13	OUT 2 (LED)
2	WATCH	14	VDD
3	F.U.	15	CLKOUT
4	RST	16	OSC
5	GND	17	INTOUT, Integrator
6-12	F.U.	18	INTIN, Integrator
(F.U. Factory Used)			



Absolute Maximum Ratings:	**min.**

V_{DD}	0	7.5	V
Operating current I_{DD}	-	50	mA
I/O pins	-0.6	V_{DD}+0.6	V
INPUT-port pin-No. 4,18	-	+/- 500	µA
OUTPUT-port pin-No. 1,2,6-13,15,17	-	+/- 20	mA
Total power dissipation	-	800	mW

Supply: at 25°C	**min.**	**typ.**	**max.**	**Units**
V_{DD}	3,0 V	5.0 V	6.25	V
Standby current (OUT1/2 n.c.)	-	1.8 mA	3.3	mA
Characteristics: at 25°C	**min.**	**typ.**	**max.**	**Units**
Input low-value	V_{SS}	-	0.2V_{DD}	V
Input high-value	0.2V_{DD}+1	-	V_{DD}	V
Input leakage current	-1	0.5	+1	µA
Output low-value (I_{OL}=8.7mA, V_{DD}=4.5V)	-	-	0.6	V
Output high-value (I_{OH}=-5.4mA, V_{DD}=4.5V)	V_{DD}-0.7	-	-	V
RESET low-timing (pulse width)	100	-	-	ns
RC-oscillator (10k,120pF)	-	625	-	kHz

Functional Description

The CCS Controller with appropriate circuitry controls the charging of a rechargeable battery up to 100% of the available capacity. The inner impedance between electrode and electrolyte is used for the determination of the 100% full charge state (patented worldwide). In addition the CCS Processor features a battery fault detection and an intelligent recharging procedure for maintaining charge in standby operation without derating the performance of the battery by memory effect. Automatic on/off switching of the charging current is controlled by a fail-safe Watch Dog Circuit (WDC).

Charge Current:
To ensure best results it is necessary that the parameters remain inside their computational limits. Therefore the mean charging current should be stabilized around 1C_A (0.5-2).

Power Source:
For the calculation of the inner impedance (according to the new process) it is essential, that the power is supplied with the sinusoidal 100/120Hz pulsation of the rectified line current.
Although the battery is charged correctly in many cases, the use of a DC current may not prevent in every condition from uncertain calculations which may lead to premature shut off, overloading, excessive heating and damage of the battery and surrounding material. Therefore the use of a smoothing capacitor as well as the operation from a DC supply (battery) without a BTI DC-Interface is strictly forbidden.

Process Timing:
The moment, the power supply is switched on (t0), the processor is in standby operation until the duty cycle on pin 17 (integrator out) is lower than 23% (battery is connected). When a battery connection is detected (t1), the CCS9310CTC starts the measurement of the inner impedance and switches on a pulsating charging current (t2). When the measurement of the inner impedance of the battery points to a 100% full charge, the processor switches off the charging current (t3).

Battery Fault Detection:

a) Over voltage (open circuit): If the battery voltage exceeds the upper „limit S2“, the charging process stops immediately. The charging cycle will be restarted for a maximum of two times. If then the voltage is below that limit the charge process will continue, when it is still above the limit the charge process is interrupted and the controller signals „Battery defective“.

b) Under voltage (shorted cell): If, at moment t3, the battery voltage is below a defined lower „limit S1“, the charging cycle will be restarted for a maximum of two times. If the voltage is still out of that range, the controller signals "Battery defective" (LED flashing). If the battery is not disconnected, recharge will follow in every case.

Recharge:
The first recharge starts at moment t4. The shut off is detected by measurement of the inner impedance of the battery as mentioned before (t6). The time distance to the next recharge is determined by the processor.

Standby:
Because of the intelligent recharge, even for the battery with load ($I_{Standby}<0.2C_A$) a residual capacity of approx. 80% of the nominal capacity can be achieved any time ($I_{Charge} = 1C_A$).

Process-Timing

t0-t1	Delay	Until battery is connected.
t1-t2	1st Measurement	Approx. 20 sec.
t2-t3	Charging	Until 100% fullcharge of the battery Time depends on precharge and charging current, from 1 min. to approx. 30 min. at $2C_A$ (60 min. at 1 C_A, 120 min. at $0,5C_A$)
t3-t4	Delay	Until next recharge, MC-controlled
t4-t6	Charging	Recharge (similar to t1-t3)

Pin Descriptions

Pin 5	GND	Ground
Pin 14	V_{DD}	Positive Input Voltage
Pin 4	RST	GND = RESET / V_{DD} (Pull-up) = program start Rising edge to V_{DD}, RESET-TIME = 18 msec
Pin 16	OSC	R/C Oscillator Input
Pin 15	CLKOUT	Oscillator Output (1/4 f_{OSC})
Pin 17	INTOUT	Integrator-Output: pulse, period T approx. 52 ms Duty cycle (H/T) < 23%...battery connected Duty cycle (H/T) up to approx. 23%... measurement, battery full Duty cycle (H/T) < 14%...battery fault , limit S1 Duty cycle (H/T) over 23%...battery fault limit S2, no battery
Pin 18	INTIN	Integrator-Input
Pin 2	WATCH	Control Input for charging current (off = 0V, on = approx. 16 kHz)
Pin 1	OUT 1 (Buzzer)	Status-Indicator 1 (square wave 0V-5V) Supply "ON": approx. 1 sec. 550 Hz Battery connected: approx. 2x0,5 sec. 550 Hz Charging cycle: pulses approx. 0,3 msec./sec. Battery full: approx. 1 sec. 550 Hz Interrupt of charging: approx. 3x(2x0,5) sec. 550 Hz Battery fault: approx. 5x0,5 sec. 550 Hz Battery disconnected: repetition of the last signal
Pin 13	OUT 2 (LED)	Status-Indicator 2 (level 0V-5V) Battery connected: output HIGH Charging cycle: output stays HIGH Battery full: output LOW Battery fault: 1 Hz until next recharge

CHARGE-DIAGRAM: FULLCHARGE OF A BATTERYPACK

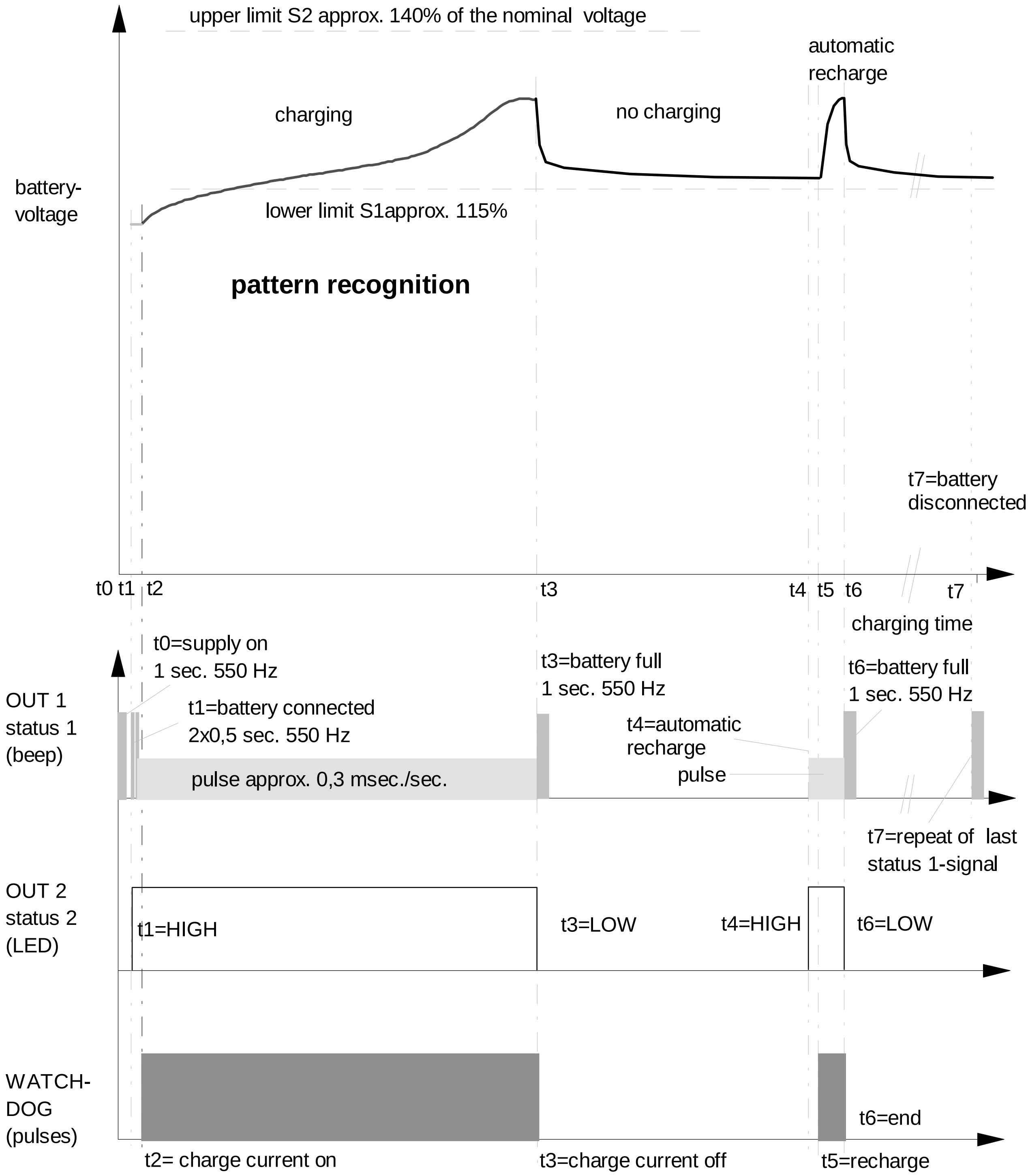
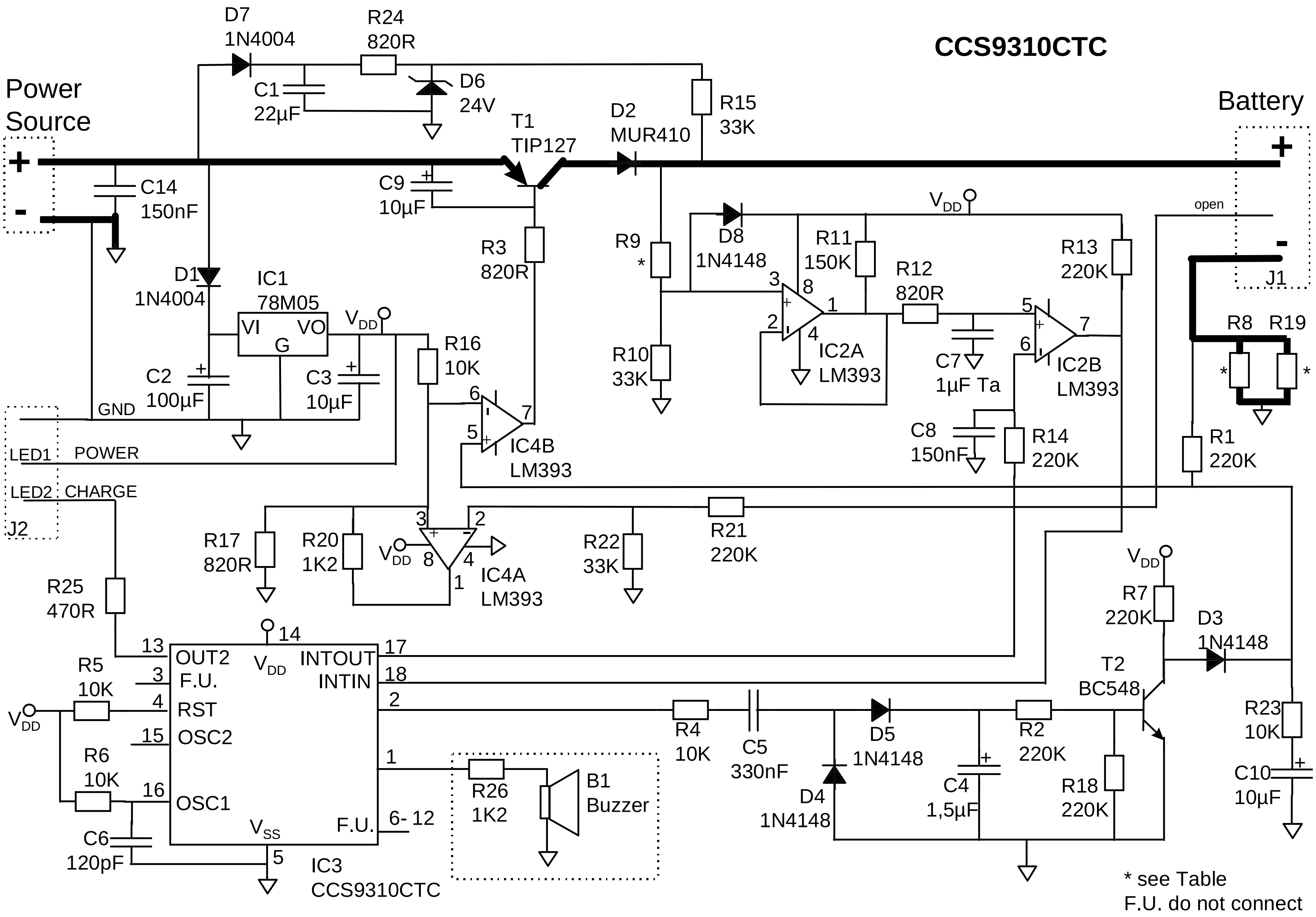


diagram not in real scale

Event t0 : supply on.
Event t1 : battery connected, measurement of the inner impedance of the battery for approx. 20 sec.
Event t2 : start with battery charging
Event t3 : end of charge, automatic cut off controlled by the processor, battery must not be disconnected
Event t4 : automatic recharge, controlled by the processor
Event t5 : battery recharging
Event t6 : end of recharge
Event t7 : battery disconnected

Electronic Circuit:



Application:

Power source:
The circuit must be supplied with a full-bridge rectifier - **no smoothing capacitor**! As supply voltage V_{in} use a rectified 50/60 Hz AC voltage pulsating with a 100/120 Hz frequency.

Charging current:
The charging current should come up to approx. $1C_A$ (limits $0{,}5\text{-}2C_A$):
$I_{Charge}=U_{ref}$ / Resistor R8 parallel to R19; with $U_{Ref}=0{,}38V$.

Table 1: Battery voltage with Resistor R9

Number of cells	1	2	3	4	5	6	7	8	9	10
Battery nominal-voltage	1,2	2,4	3,6	4,8	6,0	7,2	8,4	9,6	10,8	12,0 V=
Resistor R9	1k	34k	67k	100k	133k	166k	199k	232k	265k	298k
V_{in} typ.	9	9	9	10	12	14	16	18	20	22 V_{eff}

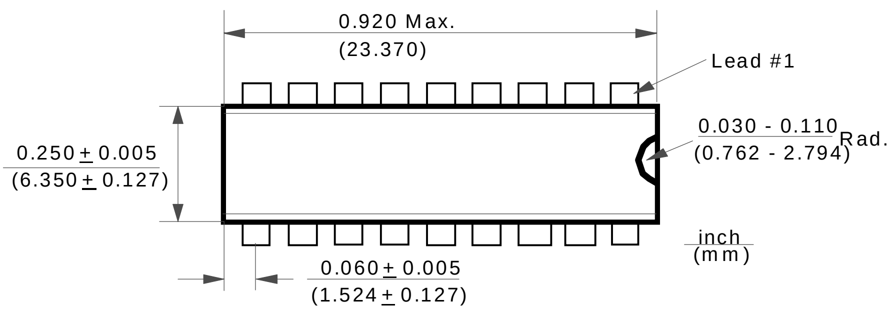
R9 is calculated for a battery voltage of 1,2V / cell!

Operating Instructions:

1) Power supply on: 1 beep (standby), green LED (LED 1) on.
2) Battery connected: Beep 2 times and red LED (LED 2) on.
3) Battery fully charged: 1 beep and red LED off.
4) Battery fault: 5 short beep and red LED flashing.
5) Interrupt: 3 times 2 short beep.
6) Battery disconnected: Last signal repeated (full or fault).
7) During charging: Click with 1 sec - period and red LED on.

Package:

18 - Lead Plastic Dual In-line **DIP 18**



CCS-Options

CCS-Evaluation Board, Kit:
Universal-Charging Kit or Board: 1-10 cells in series, 100mA-2A

Extension:
Circuit description to charge **1-36 cells** in series

DC-Interface:
Additional module for to
- Reduce the power loss at the linear transistor; smaller heat sink
- Charge the battery also from a DC-supply (e.g. car battery)

8-fold Multiplexer:
With the BTI multiplexer circuitry it is possible to charge 8 independent battery packs automatically and in series.
The batterypacks can differ in chemistry, capacity (0,5 - 2 C) and type but they must have the identical battery voltage (number of cells).

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