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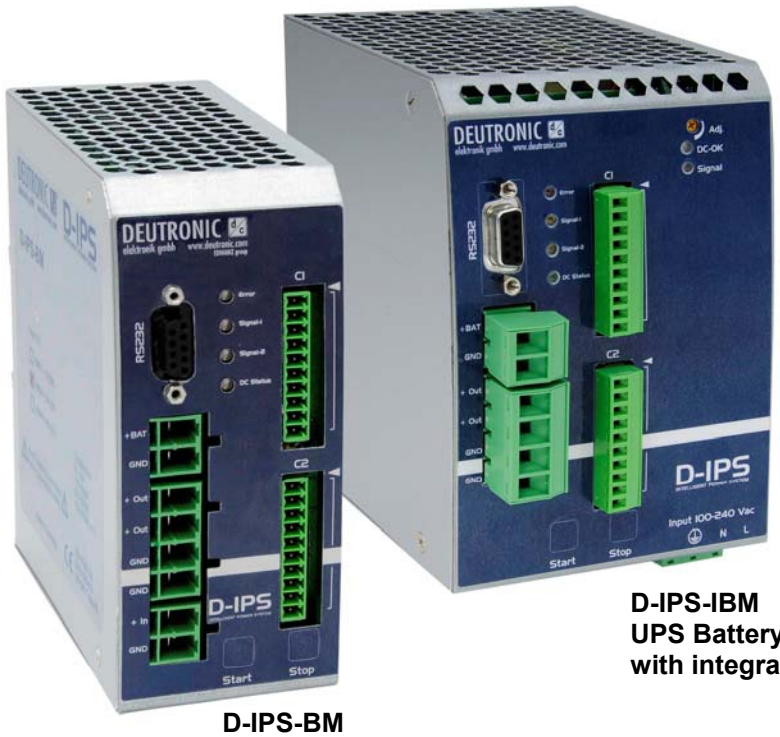
D-IPS ACS - Temperature Compensated Battery Charging and Diagnostic Procedure

for the UPS Battery Management System D-IPS-BM and D-IPS-IBM



D-IPS-IBM
UPS Battery Management
with integrated D-IPS Power Supply

D-IPS-BM
UPS Battery Management

Presented with the E.ON 2009 environmental prize, Deutronic D-IPS ACS battery charging and diagnostic procedure (ACS = Adaptive Current Step) is an innovative and extremely efficient procedure for UPS systems with lead-based batteries (e.g. standard, AGM, gel, pure lead).

The D-IPS-BM (UPS battery management system for TS35 DIN rail) integrated temperature compensated ACS procedure enables a charging factor[1)] of up to 1,02, i.e. a charging efficiency up to 98% (currently charging factor values about 1,10-1,20 are common). It protects against the so-called thermal “run away” of the battery and offers a very careful battery charging. Furthermore, the D-IPS ACS procedure extends the life-cycle of the utilized battery and considerably reduces the amount of energy for trickle charging - as opposed to common procedures available. Additional features include the configuration possibility using PC-Tool with state-of-charge and state-of-health report for the battery.

The battery management system offers versions for 12V, 24V and 48V lead-acid batteries as-well-as equipment with integrated AC power supplies (D-IPS-IBM), which are carried out in established D-IPS technology power supplies with a digitally controlled input circuitry.

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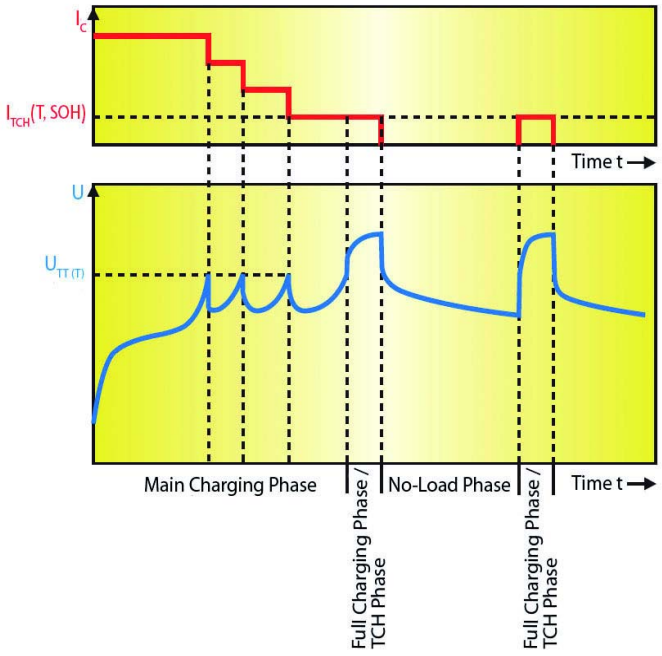
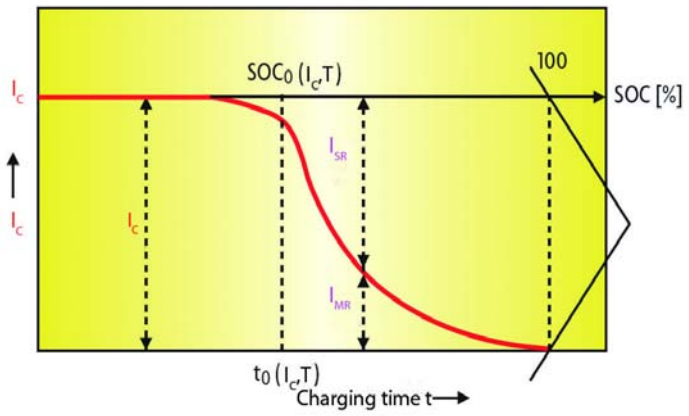
Main Charging Phase:

- The *CONSTANT CURRENT CHARGING* enables an ideal quick charging of the battery with high charging current and relatively low temperature compensated charging voltage (far below the gassing voltage).
- *ADAPTIVE CURRENT STEP CHARGING PROCEDURE*: Immediately the algorithm detects the onset of secondary reactions in a relevant magnitude, the next constant current charging step is activated.
- According to the ascertained battery parameters the procedure is repeated until the lead-acid battery is nearly charged.



Full Charging Phase / No-Load Phase:

- At the end of the charging process there follows a short *FULL CHARGE / TRICKLE CHARGE PHASE (TCH)*, after this is a change to the *NO-LOAD PHASE* (*OCV = OPEN CIRCUIT VOLTAGE*).
- During the no-load phase the lead-acid battery is *CONTINUALLY MONITORED*. Until recharging occurs, the charge status drops during the no-load phase by a max. 3-5% (charging takes place at the latest after 23 days). The duty factor of the recharging phases is below 1‰, which enables high *ENERGY SAVINGS* and at the same time *REDUCED AGEING*.



TECHNICAL NOTE:

With traditional, standard IU procedures nearly all the energy fed into the battery during the trickle charge phase is expended in side reactions (SR) and hence in the ageing of the battery - with simultaneous deficient charging of the battery (explanation - cf. the following description “serial effect”).

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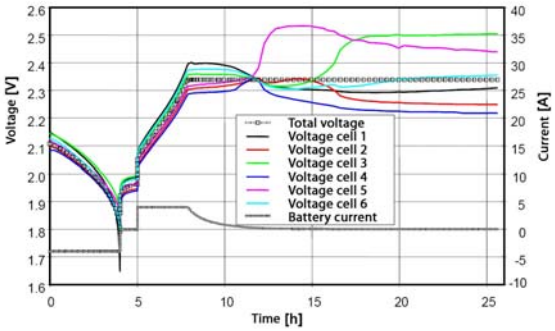
Compare D-IPS ACS Procedure with Conventional IU-Charging Procedures

Serial effect:

- The adjacent diagram shows the trend of the individual cell voltages in a 12V AGM UPS battery. To provide reproducible conditions for the subsequent charging procedure at the beginning of the recording the battery is *DISCHARGED*.

- After a short pause, charging is commenced with a CONSTANT CURRENT PHASE and then subsequently transferring into a CONSTANT VOLTAGE PHASE. The charging current is portrayed by the curve in the lower part of the diagram.



SOURCE: B. Fricke et. al., *Lead accumulators for stationary power supplies*, "Belecker Fachtage", 2004

TECHNICAL NOTE:

During the *CONSTANT CURRENT PHASE* (cf. ACS procedure) the cells behave homogeneously. Internal parameter changes have no effect on the terminal voltage of the other individual cells, because the same current is continually flowing through all cells.

- *SERIAL EFFECT* - the *NEGATIVE RESULTS OF CONSTANT VOLTAGE CHARGING* become apparent through a considerable divergence of the individual cell voltages as the resulting cell-voltage behaviour shown in the diagram above.
  During a charging procedure to fully charge a lead-acid battery, the change of any single cell effects all other serially connected cells. During the course of the charging procedure with constant voltage charging, some individual cells develop higher contact voltages, whereas other cells are increasingly less charged and even give-up their charge, so that the contact voltage decreases. The reason for this are inhomogeneities of the cell parameters within the battery (as for example differing internal resistances or SOC= *STATE-OF-CHARGE*).

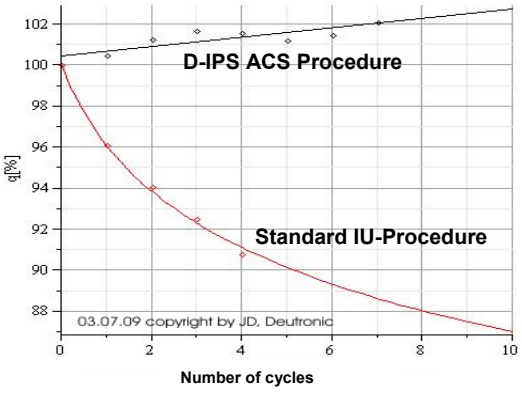
TECHNICAL NOTE:

Consequence of *CONSTANT VOLTAGE CHARGING* is an excessive ageing of the battery because single cells are being overloaded during charging procedure while other cells in the battery receive insufficient charge!

Charging Cycles / Capacity Behaviour:

- The adjacent diagram shows the capacity behaviour of a UPS battery (type: gel, 12V/60Ah) over multiple charging and discharging cycles.

- The *D-IPS ACS PROCEDURE HOLDS THE BATTERY CAPACITY STABLE*, whereas after only a few charging/discharging cycles the capacity of UPS battery charged with the conventional IU charging procedure will be noticeably reduced due to deficient charging.



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Overview of the D-IPS ACS procedure characteristics:

- **Adaptive procedure** - real algorithms, no internal access to any battery characteristics on a database
- **Temperature compensated diagnostic procedure** - for ageing determination (SOH = State-Of-Health) of lead-based UPS batteries
- **Thermal management** - prevents the thermal "run-away" of the battery
- **Dynamic adaption** of the charging parameters in relation to the temperature as well as the charge (SOC) and ageing status (SOH) of the battery
- **Regeneration** of aged (sulphated) cells
- **No serial effects** - D-IPS ACS maintains the battery capacity (high cycle consistency)
- **Fast charging capability** without detrimental consequences for the battery
- **No permanently connected charging voltage**
- **Reduction of the yearly energy consumption by typically a factor of 10** (compared with conventional procedures)
- **Charge factor[1)] until 1,02** (customary values are typ. 1,10-1,20)

[1)] **Charge factor κ :**
* Describes the ratio between the energy used during charging and the actual charge absorbed by the battery

* Charge factor κ is the reciprocal of the charging efficiency η

Charge factor κ = 1/η

Certification of E.ON 2009 environmental prize